Roads and Streets

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Confusion on the Day Labor Question

Right settlement of the question of day labor on public work would be hastened by more impartiality in the discussions of it. Unfortunately the loudest voices on both sides are those of persons shouting in their own interests—a proceeding calculated to strengthen the zeal of minds already made up, but confusing to such as are merely interested in a right solution.

Obviously we cannot criticize a person for speaking in his own behalf so long as he sticks to facts; but with contradictions running free, and no authoritative neutral agency to settle them, the outsider is bound to be puzzled unless he has unusual opportunity and inclination to study the question.

Engineering and Contracting lays no claim to membership in the neutral class, but is trying to be fair. As our readers know, we are firm believers in the superior economy and efficiency of construction by contract, which belief we base on careful consideration of comparative records by the two methods.

It is true that some (a minority) of the published records of day labor construction show costs lower than contract bids on the same work or lower than fairly comparable contract costs on work elsewhere. A few of these undoubtedly are correct. It would be astonishing if there was never an efficient day labor job. But the great majority of apparently economical day labor work gets its appearance from imperfect records.

It is difficult to disguise the cost of a contract job. So much per unit or so much for the job, paid out of the public treasury, tells a pretty definite story. But with day labor it is different. On most public works there are a multitude of ways in which costs can be shifted from their proper place to some position where they will not attract attention. This condition is not so bad now, since the extension of improved accounting methods, as it was formerly; but it still obtains in many places, and even the best of accounting cannot wholly prevent it.

Some men may shift costs in this way and feel, that so long as they are merely making a good showing for themselves without any actual "graft," they are doing nothing very wrong. We shall preach no sermon on the morals of such acton. The practical effect, however, is to encourage the continuance of wasteful methods; and the man who deliberately wastes public money is little better than the one who steals it. Perhaps if some of the officials who have followed these practices would consider them in all their phases, they would regret the past and correct their action in the future.

This is the most serious source of confusion in the issue between day labor and contract work. If true records were presented the case would be practically settled. Minor sources of confusion lie in the unwise zeal of enthusiasts (often sincere) on both sides. Some opponents of day labor concede no single virtue to it, exaggerate its inefficiency, call it a road to communism, and indulge in other extravagances at once ridiculous and disgusting. On the other hand, governmental fanatics—not all of them wearing the button of the Socialist Party—refuse to recognize evidence of the economy of contract work, dogmatize that gov-

ernmental forces should construct all public works, and press their cause generally in a way calculated to hurt rather than help it. Confusion ultimately is a loss to both sides.

Vehicle Speed and Highway Capacity

One of the most interesting statements made at the National Conference on Street and Highway Safety, held at Washington in March, did not deal primarily with safety. It was a statement of the relation between the speed of vehicles and the capacity of highways, and disclosed what doubtless has been recognized before but with little or no publicity—that a road will accommodate more cars at moderate speed than at high speed. In other words, there is a critical vehicle speed above or below, which highway capacity decreases. This is due to the necessary increase in spacing between cars as their speed increases, and is at the surprisingly low limit of 22 miles per hour at the point tested. The statement was made by Col. Nathan W. MacChesney, of Chicago, and was reported in the daily press as follows:

"As you increase speed you cut down the number of cars that Sheridan road or 5th avenue will carry because you must simultaneously increase the intervals between cars. At 23 miles an hour 2,600 cars could pass a given point on Sheridan road; at 26 miles, 2,570 cars; at 31 miles, 2,500 cars; at 34 miles, 2,400 cars, and at 40 miles, only 2,080. But curiously enough when you decrease speed to 20 miles, you again moved 2,570 cars, as for 26 miles and at 14 miles only 2,400 cars, as at 34 miles. Our studies show that at 22 miles you got about the maximum capacity of the road."

Presumably the critical speed will vary somewhat with conditions such as width of road and number of traffic lanes, character of traffic, character of traffic supervision, frequency and duration of interruptions from cross traffic, and the like. It can be determined wherever necessary, and traffic supervision based on a knowledge of it should materially help conditions at many places. The accumulation of such knowledge is gradually making an exact science of highway traffic.

Slate Dust for Roads

Experiments with state dust in road construction, with a view to finding a profitable use for large waste banks of local quarries, have been made by E. I. Evans, Surveyor to the Festiniog Urban District Council, Merionethshire, England. Our English contemporary The Surveyor, London, states that Mr. Evans discovered an excellent mortar could be made of a mixture of slate dust and pinegum, which, with granite macadam, produced a hard, resilient surface. The experiment was tried on a 200-yd. stretch of road along which the motor-bus traffic to Merioneth and South Carnarvonshire passes. Heavy rains fell during the construction, and a dry spell of five weeks followed. It was feared the surface would crack, but it stood the test excellently. It was not watered during the whole of the five weeks, and was practically dustless. Mr. Evans formed the view that if tar-sprayed it would be as good as, if not superior to, a tar-macadam road. It remained to be seen whether the new method would stand the strain of hard winter conditions.

Road and Street Contracts Awarded During the Last 74 Months

The accompanying table, compiled from statistics in the Engineering News Record, shows three outstanding facts: First, that highway contracts awarded during the last half of each year have averaged only 25 per cent less in volume than those awarded during the first half; second, that there is not a month in the year without a very large volume of road and street contracts awarded; third, that each year shows a substantial gain over its predecessor.

ROAD AND STREET CONTRACTS EXCEEDING $25,000 IN SIZE

	1920	1921	1922	1923	1924	1925	1926
January	$ 12,204,000	$ 11,598,000	$ 14,424,000	$ 21,691,000	$ 16,972,000	$ 22,720,000	$ 19,989,000
February	21,334,000	12,049,000	9,052,000	18,781,000	19,214,000	20,104,000	12,189,000
March	26,221,000	25,880,000	39,669,000	37,706,000	41,395,000	25,910,000	.....
April	33,340,000	31,026,000	32,991,000	29,641,000	43,513,000	60,801,000	.....
May	30,258,000	35,064,000	42,284,000	46,528,000	65,354,000	53,418,000	.....
June	31,441,000	56,777,000	42,138,000	33,046,000	44,494,000	42,451,000	.....
July	29,353,000	33,943,000	26,087,000	42,397,000	45,784,000	45,246,000	.....
August	18,565,000	28,693,000	37,035,000	35,639,000	40,536,000	41,199,000	.....
September	26,537,000	23,257,000	28,334,000	37,812,000	44,585,000	36,949,000	.....
October	12,894,000	20,055,000	23,162,000	28,144,000	35,198,000	31,416,000	.....
November	12,443,000	20,751,000	20,892,000	23,683,000	18,382,000	23,492,000	.....
December	10,834,000	16,263,000	18,096,000	21,035,000	14,894,000	19,635,000	.....
Total	$265,424,000	$315,356,000	$334,741,000	$381,097,000	$430,231,000	$423,341,000	.....

Note.—About 100 per cent must be added to these totals to give the grand total of highway contracts in the United States.

Bridges are not included, and bridge contracts average 15 per cent as much in value as road and street contracts. A great deal of road and street work is done by directly hired labor and is not included above.

More Than Billion Dollars for Rural Roads in 1926

Highway construction and maintenance in 1926 will equal and possibly exceed the progress made in any other year, according to estimates from the various states compiled by the Bureau of Public Roads of the United States Department of Agriculture. A total of $1,030,286,948 is available for the construction and maintenance of all rural roads.

Fifty-eight per cent or $558,590,948 is to be available to the state highway departments, of which $461,515,400 is for construction and $137,075,548 for maintenance. These funds will provide for the construction of 6,751 miles of asphalt, concrete and brick paving, 14,320 miles of sand-clay, gravel and macadam and 8,145 miles of improved earth road. The states also plan to maintain 234,582 miles of road.

The total expenditure by counties and local units for both maintenance and construction is estimated at $431,696,000, which is less than the similar estimate made one year ago by about $31,000,000. This reduction is more than offset, however, by the increase of more than $58,000,000 in funds estimated as available to the state highway departments. For a number of years there has been a trend toward placing control of all important state roads in the hands of the state highway departments.

The funds available as reported by the various states and the portion of the state funds derived from Federal aid are as follows:

	Probable expenditure by State highway departments	Federal-aid funds available to States[1]	Probable expenditure by local authorities
Alabama	$ 9,900,000	$ 3,547,911.69	$ 12,000,000
Arizona	4,200,000	3,084,742.68	630,000
Arkansas	6,500,000	1,534,751.77	9,000,000
California	14,000,000	4,248,299.76	23,000,000
Colorado	4,550,000	3,285,370.65	5,000,000
Connecticut	7,785,289	1,611,062.57	2,500,000
Delaware	2,930,000	367,537.65	900,000
Florida	14,000,152	1,400,910.74	18,000,000
Georgia	7,324,750	1,931,087.02	13,000,000
Idaho	2,837,000	1,271,409.28	1,500,000
Illinois	46,200,000	6,674,248.74	20,000,000
Indiana	13,200,000	2,382,667.87	40,000,000
Iowa	13,584,108	4,028,631.46	16,000,000
Kansas	9,072,000	3,073,331.15	10,000,000
Kentucky	12,000,000	2,486,349.23	10,000,000
Louisiana	9,250,000	1,856,350.57	7,000,000
Maine	3,983,400	1,513,478.38	3,900,000
Maryland	7,116,398	654,880.74	3,200,000
Massachusetts	13,000,000	2,673,200.94	12,000,000
Michigan	11,500,000	4,603,378.63	22,000,000
Minnesota	21,500,000	2,111,863.44	6,500,000
Mississippi	6,250,000	1,698,458.08	6,000,000
Missouri	28,076,000	2,600,235.10	12,000,000
Montana	1,350,000	5,714,746.27	1,000,000
Nebraska	6,500,000	3,941,841.00	8,500,000
Nevada	1,670,000	1,049,593.49	400,000
N. Hampshire	3,550,000	511,347.83	1,500,000
New Jersey	22,900,000	985,680.83	8,300,000
New Mexico	3,555,553	2,750,373.17	200,000
New York	35,750,000	6,938,224.36	26,641,000
N. Carolina	16,000,000	1,715,137.99	10,000,000
N. Dakota	5,450,000	2,506,152.20	3,500,000
Ohio	25,500,000	4,502,826.16	20,000,000
Oklahoma	10,000,000	1,894,068.61	12,000,000
Oregon	7,000,000	1,319,943.74	7,000,000
Pennsylvania	63,550,000	3,699,149.10	12,500,000
Rhode Island	3,790,000	675,753.65	875,000
S. Carolina	5,540,000	892,885.46	2,500,000
South Dakota	3,350,000	1,282,672.87	5,250,000
Tennessee	18,000,000	2,374,596.79	9,000,000
Texas	28,000,000	4,979,640.84	16,000,000
Utah	3,640,798	1,502,010.18	500,000
Vermont	3,530,000	801,796.98	700,000
Virginia	10,285,500	1,481,535.84	2,600,000
Washington	9,000,000	1,527,002.22	11,000,000
West Virginia	13,750,000	912,454.24	6,000,000
Wisconsin	20,970,000	5,143,634.95	10,700,000
Wyoming	2,200,000	1,024,811.51	900,000
Totals	$598,590,948	$118,768,488.42	$431,696,000

[1]Included in total probable expenditure by State highway departments, 547-26.

English Roads

At the present time there are 153,000 miles of road in England and Wales, administered by 1885 highway authorities. The main trunk roads are under the charge of the county officials, but these account for less than 20 per cent of the total, and the remainder are administered by various authorities, ranging from county boroughs to rural district councils. Of the 153,000 miles, 20 per cent, or approximately 30,500 miles, are classified, and, as such, receive grants from the Ministry of Transport, representing 50 or 25 per cent of the approved expenditure, according as they are placed in Class I or Class II. The total expenditure of local authorities on the maintenance, improvement and cleansing of roads and bridges in England and Wales during the year 1922-23 was £40,246,000, equal to £1 1s. 1d. per head of the population. This sum includes the grants from the Road Fund, of which the revenue for the current year is estimated at 17½ million pounds. The contribution from the Road Fund towards the upkeep of classified roads is approximately 11 millions, the balance being devoted to the other necessary improvement works. Unlike the railway—considering both as the permanent way—every penny spent on roads is provided by taxation—say, one-third by motorists of all classes and two-thirds by the local ratepayer.

International Road Congress.—The 5th International Road Congress will be held at Milan, Italy, Sept. 6 to 13, 1926. While the Congress is in session an International Roads Exhibition will be held at Milan from Sept. 1 to 20 for the display of materials and plant used for roadmaking and road maintenance.

Colored Pavements—According to Roads and Road Construction, London, the Malden and Coombe (Surrey, England) Urban District Council, which is now laying down new streets in concrete, has lately completed one with a pink-colored surface. The surface pigment has been introduced to harmonize the street with the paving stones, which are of a reddish color.

Macadam Maintenance

Methods in Prince Edward County, Ontario, Described in Paper Presented Feb. 22 at Conference of County Road Superintendent

By E. D. COX
Road Superintendent, Prince Edward County

In dealing with the subject of waterbound macadam road maintenance I think it better to take my own experience in Prince Edward County.

We have tried several methods with a certain degree of success. When the holes are large enough, we find that patching with 2 in. stone, well rolled in with the roller, will give good service for a season. A stone road which is worn and full of small holes can be scarified, graded and rolled, and made into a fair road for a season or two, if enough water, brooming and rolling are used to get it well sealed, so that the road will not ravel.

The method we have been following during the last three or four years is to treat the road with asphalt and patch with cold patch. In preparing the road for treatment with tar or asphalt if the road is new, the fine chips should be worn away so that the larger stones show through, and then it should be thoroughly clean. Of course, any road should be clean before treatment.

We use a 50 per cent asphalt, which is heated before applying. We find 50 per cent gives better penetration under all conditions of weather, and penetration is absolutely necessary to keep the surface from peeling off. If the road treated has a heavy traffic washed gravel or chips give decidedly the best results. If traffic is light sharp sand will do fairly well. We treated 59 miles of road the past season, 4 miles being covered with washed gravel, 13 miles with chips and the balance with sand.

Next season I should like to cover at least one-half of the roads treated with washed gravel. In covering the asphalt with sand it is best to let it set from 6 to 12 hours; but my life would not be worth living if the asphalt is not covered as fast as it is applied; therefore, the next best course is to use as little sand as will keep it from sticking, as too much sand makes it crumbly and a lot of the surface treatment goes to the side of road. You can cover the asphalt with washed gravel or chips as fast as it is applied, as these do not absorb the asphalt and interfere with penetration.

Our method of patching roads is to use crushed stone which passes through a screen with 1¼ in. openings, which make the stone smaller than the standard inch stone. Mixed with cold patch this has given good results.

Last season it was late before we could start patching. Our method was to put the cold patch in the holes and sift the stone in after the stone was well pounded. The cold patch was not brought closer than ½ in. from the top of the stone. After about two days we found a nice patch about level with the surface of the road.

We did not find more than one out of ten which we could call faulty. Of course, a faulty patch will shove and the only remedy is to take it out and fill again. I believe we have obtained as good results with much less labor as we did with mixing before applying.

Improved Sanitary Conditions Follow Reduction in Horse Traffic

The improved sanitary conditions on urban streets resulting from the replacement of horses by motor vehicles was pointed out by W. A. McLean, former deputy minister of highways of Ontario, in a paper at a recent meeting of the Engineering Institute of Canada. He stated that the menace of offensive street dust has been greatly lessened. It is no longer necessary to permit a thick layer of refuse to accumulate throughout the winter, to be removed in the spring. The garage has taken the place of stables with their adjacent piles of manure. Filth-carrying flies have had their breeding places lessened in stables and on the streets. Much less street refuse reaches the sewage disposal plant, but the problem of oil waste has taken its place.

Street cleaning has become a much simpler operation, and the amount of refuse to be removed has been substantially reduced. The number of men composing the old "white-wing brigade" has been greatly lessened. The following statistics from Toronto are representatives:

Year	No. of men employed	Refuse removed cu. yds.	Miles of paved street
1914	440	139,000	323.02
1924	138	75,000	446.41

That is, in 1914 one man was required for each ¾ mile of pavement for street cleaning operations. In 1924, the average is one man for 3¼ miles. In 1914 the refuse removed from streets was 430 cu. yds. per mile annually; in 1924, the amount was less than 168 cu. yds. per mile, or about 39 per cent of that removed in 1914.

Subgrading for Concrete Pavements

Increased Cost Due to Improper Fine Grading Methods Discussed in Paper Presented January 13 at Convention of American Road Builders Association

By C. J. MORITZ

President, C. J. Moritz, Inc., Contractors, Effingham, Ill.

What are proper fine grading methods and what are improper fine grading methods is difficult to determine. The general custom throughout the United States, especially in the localities where the subgrade is composed of suitable homogeneous material is the use of mechanical devices commonly called subgraders. Some of this equipment is arranged to run on forms pulled by tractors, others are blades direct connected to tractor power. Experience teaches us that this is the proper method. Where the materials in the subgrade do not permit the ordinary mechanical devices, the approved method is still the use of old time pick and shovel, mattock and rakes, etc., commonly called the hand method. There may be unusual conditions under which special and unique methods may be developed. For the purpose of this discussion we may assume that the present day contractor uses proper methods.

Specified Thickness.—Formerly when a certain thickness of pavement or pavement base was specified it was generally understood both by the engineer and the contractor that the specified thickness referred to the average thickness with limited variations therefrom either plus or minus. Some engineers considered that an inch variation either way was permissible; others that ½ in. either way was satisfactory provided the average thickness was as specified.

Recently, however, there has been a tendency among the engineers and interpreters of

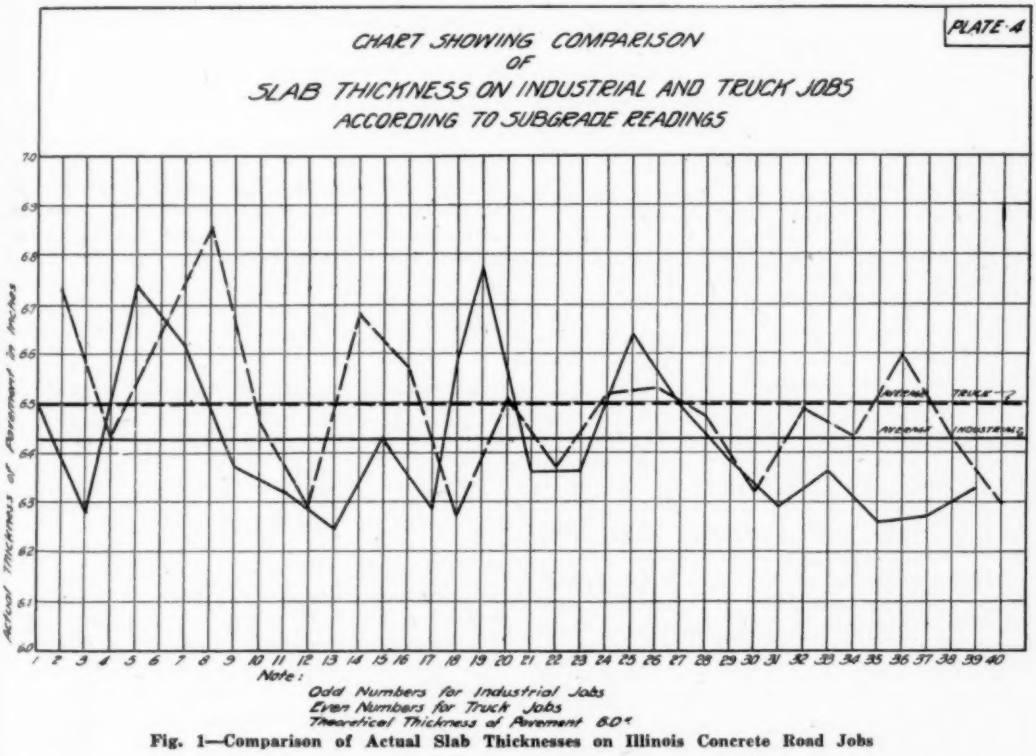


Fig. 1—Comparison of Actual Slab Thicknesses on Illinois Concrete Road Jobs

present day specifications that the thickness specified is not construed as an average but as a minimum thickness allowable.

This change in attitude, therefore, has made the matter of preparing subgrades of prime importance to the contractors. They are now forced to consider seriously how much additional expense is justified in preparing the subgrade to avoid the added expense of building a thicker pavement than the contract required.

Information obtained from various contractors has shown us that the basis of arriving at the items of cost included in what the contrator considers the cost of subgrading has been so variable that they are not comparable. Suffice it to say that the average costs as reported have varied from 1 ct. to 15 cts. a square yard of finished subgrade.

COST DATA
FOR
ONE SQUARE YARD OF CONCRETE PAVEMENT VARIABLE THICKNESS
TABLE NO I

CONCRETE PROPORTIONS	QUANTITIES REQ'D CU YD			COST OF MATERIALS PER SQ YD THICK			TOTAL COST MATERIALS PER SQ YD	TOTAL COST CEMENT & FINE AGGREGATE
	CEMENT BBLS	COARSE AGG TONS	FINE AGG TONS	CEMENT @ $2.50 BBL	COARSE AGG @ $1.00 TON	FINE AGG @ $1.10 TON		
1-1½-3	1.85	1.03	0.39	1.3	3.85	2.6	2.45	3.45
1-2-3	1.70	0.96	0.73	1.2	3.4	3.3	2.07	3.7
1-2-3½	1.57	1.04	0.67	1.1	3.8	3.6	1.98	3.8
1-2-4	1.46	1.11	0.62	1.0	4.1	2.8	1.89	3.9
1-3-3	1.11	1.06	0.72	.76	3.9	3.2	1.67	3.1
1-3-6	1.00	1.13	0.63	.70	4.2	2.9	1.63	3.3

Table on Quantities per Cubic Yard taken from Tremaine & Maurer's Principles of Reinforced Concrete
Proportions reduced to tons on a basis of 2000# for Coarse Aggregate
Proportions reduced to tons on a basis of 1800# for Fine Aggregate

Table 1

The question now resolves itself into two divisions, first, the most economical method of preparing the subgrade, taking into consideration the materials in the subgrade, interference with other operations, and protection of the subgrade when completed.

Second, the effect of carelessly prepared subgrade upon the cost of extra materials and labor required in the construction of the pavement.

As previously stated the common way of preparing the subgrade is with the mechanical subgrader where conditions permit and there is no question, this is the most economical method. It is desirable from the contractors standpoint, and usually required by the engineers, to maintain at least 500 ft. of completed subgrade in advance of the mixer. This permits of economical subgrading methods and prevents possible delay to the continuous advance of the mixer.

To construct and maintain this 500 ft. of finished subgrade involves the question of possible interference and additional cost created or prevented by the various methods of hauling aggregates to the mixer. The writer operates in his own organization both industrial and truck hauling equipment. Our own costs have been so variable that I hesitate to draw any conclusions as to the relative merits of industrial and truck haulage on the cost of subgrading. To attempt to discuss the relative merits of various hauling equipment and its effect upon the subgrade without taking into consideration other phases of the operations would be of little value.

Comparison of Slab Thickness on Truck and Industrial Jobs.—From the records of the Illinois State Highway Department we have made a comparison of the actual slab thickness as constructed for a theoretical 6 in. pavement by 20 truck jobs and 20 industrial jobs. These sections were picked at random and presumably represent various degrees of efficiency in road building operations. This information is shown in Fig. 1, the dotted line representing the thickness procured on truck operations and the solid line the industrial operations. The average thickness obtained by the truck outfits was 6.499 in., or practically 6½ in. The average thickness obtained by the industrial railway outfits was 6.418 in. Further analysis of these figures was that the maximum and minimum excess thickness under both forms of hauling were practically the same. There seems to be a slight advantage in the industrial operations. This difference, however, is so small that it becomes practically negligible in so far as these forty jobs are considered.

Table 4—Comparison of Slab Thickness on Industrial and Truck Jobs According to Subgrade Readings
Taken from the records of the Illinois State Highway Department for 1925. Forty jobs picked at random.

Industrial		Truck	
Theoretical Thickness In.	Actual Thickness of Slab In.	Theoretical Thickness In.	Actual Thickness of Slab In.
6	6.49	6	6.73
6	6.28	6	6.44
6	6.74	6	6.65
6	6.62	6	6.86
6	6.38	6	6.47
6	6.32	6	6.29
6	6.25	6	6.68
6	6.43	6	6.58
6	6.29	6	6.28
6	6.78	6	6.50
6	6.37	6	6.38
6	6.37	6	6.52
6	6.64	6	6.53
6	6.49	6	6.48
6	6.39	6	6.32
6	6.29	6	6.49
6	6.37	6	6.44
6	6.26	6	6.60
6	6.27	6	6.44
6	6.33	6	6.30
Average, 6.418 in.		Average, 6.499 in.	

Now for the second effect of careless subgrade, namely, the additional cost of materials and other expense due to laying excess thickness of pavement. The individual contractor must determine for himself his practical cost of subgrading. He should likewise determine

for himself the cost of material on his particular job, analyze the same and determine to what refinement he may economically work to save the additional cost of materials and the handling thereof and maintain practical and economical subgrading operations.

Analysis of Costs for Various Conditions.—To present a typical cost analysis of these conditions I have prepared three tables on cost data for 1 sq. yd. of concrete pavement of variable thickness. Table 1 shows the various concrete proportions, the quantities of cement, coarse aggregate and fine aggregate required for 1 cu. yd.; the cost of materials in cents per sq. yd. of pavement 1 in. thick assuming the cost of the cement at $2.50 a barrel net, the coarse aggregate at $2.00 per ton, the cost of the fine aggregate at $1.50 per ton. The quantities per cu. yd. required were taken from Turneaure and Maurer's "Principles of Reinforced Concrete." The proportion of coarse aggregate was reduced to tons on the basis of 2500 lb. per cu. yd.; for the fine aggregate on a basis of 2300 lb. We find from this table that the total cost of materials on these assumed prices varies from 16.3 cts. to 21½ cts. for 1 sq. yd. 1 in. thick. These costs, of course, are not in proportion for the thickness of the original pavement because there are given expenses which must be incurred to produce the original pavement. These are only costs which the contractor must bear in laying pavement thicker than the original contract specifies.

In many cases the cement is furnished by the owner so we have the last column of this table which shows that the cost, of the aggregate only, varies from 8½ cts. to 9.3 cts. per sq. yd. 1 in. thick.

In Table 2 we have analyzed a series of cost data and reduced the same to the following hypothetical conditions. The labor costs calculated on average conditions with 40 cts. per hour common labor. Hauling costs calculated on an average condition with 2½ miles average haul. Overhead, superintendent and general expenses taken from our own experience tables. With these conditions we obtain the following labor and hauling costs which run 1.3 cts. on cement, 3 cts. for stone and 1½ cts. for sand. Our overhead, superintendent and general expense on the same basis varies as follows: ½ ct. on cement, 1½ cts. on stone and 0.7 cts. on sand. These costs are for 1 sq. yd. 1 in. thick.

From these two tables we obtain Table 3. The total additional cost of 1 sq. yd. of pavement 1 in. thick furnishing all materials and labor, etc., necessary to produce this extra in. is approximately 30 cts. including cement, fine and coarse aggregate only. It is possible to operate closer than 1 in. although such excess is not unusual. The average excess thickness seems to be about ½ in. If this be the case and the contractor's cost of materials and labor are approximately as assumed in these tables, then he has additional expenses of approximately 15 cts. per sq. yd., if he has had to furnish the cement at 9 cts. per sq. yd. if he has furnished aggregate only. The last column in Table 3 shows the cost of excess thickness of ¼ in. which runs approximately 7½ cts. per sq. yd. for all materials and 4½ cts. per sq. yd. without cement.

These tables show you the possible expense that may be incurred or eliminated by careless or proper subgrading methods.

Most contractors seem to harbor the opinion that it is cheaper to use additional materials than to indulge in extreme refinement in the preparation of the subgrade. This statement is no doubt true when the mixer is right up to the finish subgrade. If there is a relatively small spot to be remedied and brought up to the proper grade, it is no doubt more economical to waste a little material than delay the mixing operations.

COST DATA
FOR
ONE SQUARE YARD OF CONCRETE PAVEMENT VARIABLE THICKNESS
TABLE NO 2

Concrete Proportions	Labor & Hauling Costs per Sq Yd 1" Thick			Overhead Superintendent & General Expense per Sq Yd 1" Thick		
	Cement	Stone	Sand	Cement	Stone	Sand
1-1½-3	13	29	13	065	15	065
1-2-3	12	27	16	06	14	08
1-2-3½	11	29	13	055	15	075
1-2-4	10	31	14	05	16	07
1-3-5	76	30	16	038	15	08
1-3-6	7	32	15	035	16	075

Labor Cost Calculated on an average condition with 40 per hour common labor
Hauling Cost Calculated on an average condition with 2½ miles average haul
Overhead Superintendence and general expense from our own experience tables.

Table 2

Should this condition continually prevail upon your job, however, you can very readily see from the cost tables prepared that on an 18 ft. road you can afford to spend a maximum of $1,500 per mile on your subgrade if you furnish all the materials or $900 per mile if you furnish only the aggregates, in order to avoid laying ½ in. of excess thickness under the conditions mentioned above. Similarly each ¼ in. excess costs $750 and $400 per mile, respectively.

There is of course, a limit to the amount of refinement that should be exercised on the subgrade. I think you will agree with me in the statement that no machinery at present available, or that could be devised will produce and maintain a subgrade within less than ¼ in. of a given thickness, especially when it is customary to all ¼ in. variation in the finished surface of the pavement. To obtain a mini-

mum thickness of 6 in. as required by recent specifications, it is therefore necessary to lay at least 6¼ in. and unless extreme care is used in preparing the subgrade and keeping all finishing machine and subgrader, templates adjusted to their proper relative positions, the resulting thickness will be nearer 6½ in. or more. The significance of this in dollars if clearly illustrated in the tables. If now, in addition to the natural barriers to economy in this direction we add careless subgrading the resulting expense assumes astonishing proportions.

COST DATA
FOR
ONE SQUARE YARD OF CONCRETE PAVEMENT VARIABLE THICKNESS
TABLE No 3

CONCRETE PROPORTIONS	TOTAL COST OF CONCRETE MATERIALS PER SQ YD 1 INCH	TOTALS					
		1" THICK		12 THICK		14 THICK	
		WITH CEMENT	WITHOUT CEMENT	WITH CEMENT	WITHOUT CEMENT	WITH CEMENT	WITHOUT CEMENT
1-1½-3	83	2373	1675	15	89	75	45
1-2-3	83	290	170	143	83	73	43
1-2-3½	83	281	171	141	86	71	43
1-2-4	83	272	172	134	84	67	42
1-3-5	81	248	172	124	86	62	43
1-3-6	81	244	174	122	87	61	44

Table 3

To intelligently and economically produce a subgrade to practical refinements, therefore, the following conditions must be given careful study.

First, the possible effect of the hauling equipment upon the subgrading operations taking into consideration, of course, the other elements and conditions surrounding your particular problem.

Second, the proper equipment necessary to produce your subgrade depending upon the soil and materials with which you must contend.

Third, after due consideration given cost of materials, labor, hauling and other expenses as compared with the actual cost of preparing the subgrade, the constructor must determine for himself the economical plane and degree of accuracy to which it is desirable to prepare the subgrade.

Civil Service Employees of New York State Highway Department.—Under the new policy adopted last year every employee of the Bureau of Highways of New York State, with the exception of the Commissioner, his two deputies and two secretary stenographers, will be a civil service appointee. This regulation covers even the pick and shovel men.

International Roads Exhibition Buenos Aires, Argentina

The International Exhibition of Roads, Transport and Touring will be held on the show grounds of the Argentinue Rural Society at Palermo, Buenos Aires, opening May 25, 1926, and continuing for several months.

The exhibition will consist of the following sections:

Group A (ROADS), in 9 sections. Preliminary studies, construction, maintenance, machinery, materials, for earth, consolidated, and paved roads; bridges, culverts and drains; traffic regulations, speed devices, traffic signals; road education; and a special section, which provides for a competition open to large road-making and paving companies in paving with different materials roads in the exhibition grounds.

Group B (TRANSPORT), in 7 sections. Historical exhibits of primitive and modern vehicles in Argentina; use of automotive vehicles for passengers and merchandise.

Group C (TOURING), in 4 sections. Routes and resorts; maps and guides, refuges and shelters, travel agencies, tourist organizations, etc.

The exhibition is open to national, state and municipal governments and to industrial and commercial concerns. Applications for stands and space may be made by cable, using a special code which is given in the official program. Copies of the program in English may be obtained by applying to the Transportation Division, U. S. Bureau of Foreign and Domestic Commerce, Washington D. C., direct or through the District Offices of the U. S. Bureau of Foreign and Domestic Commerce.

$100,000,000 for Road Work in Australia

The Commonwealth Government of Australia has decided to undertake a road building program calling for an expenditure of $100,000,000 during a 10-year period. It is proposed to create a Federal Highways Board consisting of a representative of each of the Governments of the commonwealth and the States, of which Board the Commonwealth representative would be Chairman. The Board would, on behalf of the respective Governments, consider and decide upon proposals in relation to the expenditure of the money provided during each year, prepared by the Roads Authorities in the States, and periodically review the progress of the works authorized from time to time. The actual construction of the works would, as at present, remain in the hands of the State authorities.

Recent Developments in Bituminous Paving Practice

Improvements in Asphaltic Mixtures and Betterments in Construction Methods Described in a Paper Presented Jan. 13 Before 23rd Annual Convention of the American Road Builders' Association

By HARRY M. REX
Construction Engineer, North Carolina State Highway Commission

While it is almost impossible to pronounce judgment with any degree of accuracy in considering the contemporary development of any field of endeavor, still it is possible to distinguish certain tendencies at least in the late developments in bituminous paving practice. Immense strides forward have been taken recently in all phases of this development which, for the purpose of discussion, may be aptly separated into two classifications; namely, improvements in asphaltic mixtures and construction methods and, second, the wider adaptation of bituminous construction to local materials and conditions.

Into the first category would fall, of course, the various bituminous binding materials. Other than the extremely efficient standardization of production by the commercial manufactors and the recent reduction of the too numerous grades of asphalt to a more practical few, no great change has occurred in the most of the asphaltic binders. This should not be construed as meaning that the present day specification standards should be passively accepted as representing the ultimate of perfection, but merely that no eminent change in general asphalt requirements has come about in recent years.

Developments in Asphaltic Mixtures.—This is not so, however, with the bituminous mixtures. From time to time various ideas have been advanced dealing principally with research into sand structures, and the introduction of admixtures. In the sense that thus far the worth of those mixtures generally termed standard remains unchallenged, no outstanding example of radically different asphaltic mixture has been advanced. Nevertheless, in this connection, there are two theories lately advanced and at present being investigated which are especially noteworthy.

The first deals with the proposition that higher percentages of added filler insure higher stability results and further that extreme fineness of this material is greatly to be desired. In addition the possible superiority of hydrated lime over the usual commercial limestone dust as a filler has also been indicated by laboratory tests.

The second theory is of peculiar significance to those districts where heretofore the fitting of local materials to meet gradation specifications has been acutely problematical. It maintains that much wider gradation limits on sands may be admissable than those which now prevail. For some years very interesting experiments dealing with sand structures have been conducted by a number of men actively engaged in highway research and a number of devices for measuring stability have been designed. Perhaps the latest of these is that of Mr. Prevost Hubbard, to whom credit is due for very valuable and interesting laboratory results in substantiation of this proposition.

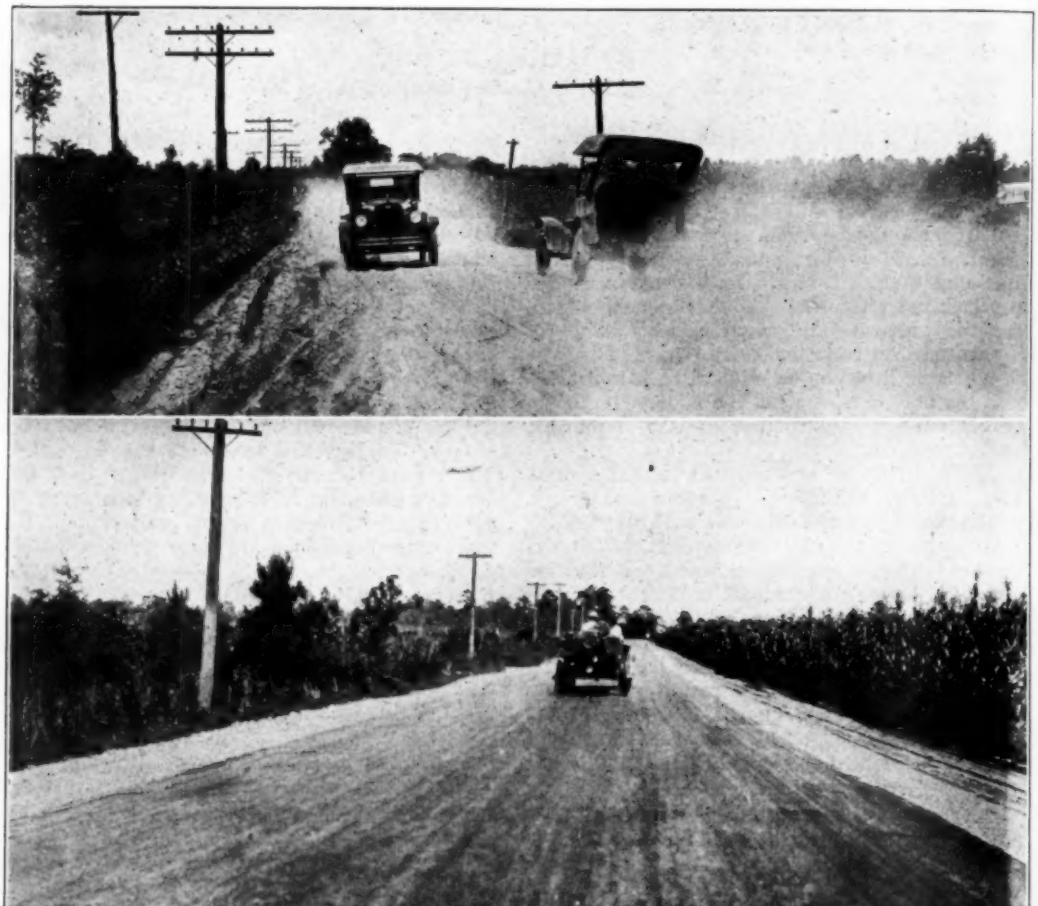
At this time it is only possible to comment on the progress of these experiments as, I believe, no definite conclusions have been determined. However, examination of laboratory analysis of compacted bituminous samples lifted in North Carolina tend to bear out this second presumption. In other words there is no apparent correlation between excellence or inferiority of sand gradation and a high or low density (relative solidity), all other influential factors being equal. It is a matter of fact that sands, in many respects far outside the bonds of what is commonly accepted as standard gradation, have sometimes been used in the construction of sand asphalt in North Carolina with gratifying results. The economic value of such widening of sand grading limits is readily apparent.

For the rest, as regards the asphaltic mixtures, it would be adequate merely to mention the growing tendency towards leaner mixtures to cope with modern traffic requirements. This applies not only to the finer graded surfacing mixtures but also to the large aggregate black bases, sheet asphalt binders and sand asphalt bases. In the latter mixtures the slight decrease in bitumen content, while sacrificing little of flexibility, appreciably increases stability.

Betterment of Construction Methods.—The interest shown towards the constant improve-

ment of asphaltic mixtures is equalled only by that directed to the betterment of construction methods. This is true from the viewpoint of not only the engineer but of the contractor as well. In general infinitely more care is being taken with the details of construction. Also it is being realized more than ever before that the riding quality and the durability of the wearing surface are dependent, either directly or indirectly, on every detail of the pavement structure from the subgrade on up to the wearing surface itself. Perhaps no better example of this can be taken than to observe the effect of the surface of a concrete base on a one-course bituminous wearing surface. If the base is rough and wavy these irregularities will show up in the surface of the top in the course of time regardless of how great pains are taken with the surface during construction of the wearing course itself. In this connection it is generally observed that while a truer surface may be obtained during construction in the case of fine aggregate mixtures laid in one course, these mixtures are more sensitive to base irregularities than the mixtures in which the larger particles predominate.

Concrete base irregularities are commonly due to careless workmanship or to the lack of proper tools. The latter item is being better taken care of in North Carolina by the introduction of a transverse wood float used behind the usual tamping template and at the present time experiments are also under way with the development of a longitudinal wood float for the use on concrete base. Two other details which have made for improvement in construction methods are the use of a straightedge on uncompacted hot-mixture materials and the



Before—and After Treatment of a Top Soil Road in North Carolina with Asphaltic Oil

decrease in depth of concrete header curb to insure the sealing of side joints. The exercise of greater care in rolling the various mixtures is also becoming more universal.

Looking at progress in methods from the contractor's viewpoint the same advance in

Top: Trimming Back Edges of Old Macadam and Setting Forms for Concrete Strips. Below: The Concrete Base with Side Strips in Place

idea is seen. Strides have already been taken in breaking away from old, costly and inefficient methods which until a few days ago were handed down from year to year unquestioned. This has been accomplished by more progressive ideas along the lines of improved plant and equipment as well as more thorough organization knowledge.

For example, in the year just past, two sand asphalt projects were awarded in North Carolina at the same letting. These projects were almost contiguous but were let to two different contractors at essentially the same unit bid price. One contractor, using a plant mixing a box of 2,000 lbs., started his 8 miles of work and finished 54 days after starting. The other contractor, using a 1,000 lb. box, started his 10 miles the following day after the award and finished 126 days after starting. The former contractor had visions of improved construction methods and worked out their fruition; the latter merely did his work in the allotted number of working days. The advantages of progressive construction ideas—to the contractor in increased profits; to the engineer in better workmanship and lessened engineering cost—are obvious.

Thus we see important steps taken in the various improvements in mixtures and construction methods which can be paralleled in progress only by another phase of development. That is, the growing realization of the adaptability of asphaltic construction to local conditions and the utilization of known mixtures to the best advantage.

Sand Asphalt Pavement.—The sand asphalt pavement in North Carolina affords an ideal example of the use of local material to good advantage and also of the constant observation and improvement necessary to bring any given pavement up to as near perfection as possible. Although eminently successful generally field indications in some cases disclosed that which might develop into a structural defect. That is, a potential plane of cleavage was being created by the facts that the present pavement was being laid in two courses and that these courses were of very different mixtures. Although the present specifications lower this plane of cleavage to a point having a reasonable factor of safety, experiments are now being carried on with the use of one course sand asphalt pavement laid to a compacted thickness of 3½, 4 and 4½ in. Other experiments are being carried on with the use of a paint coat of hot asphaltic cement thinly and uniformly squeegeed on the sand asphalt base course prior to placing the wearing surface course. The success of this method has already been indicated. It has an advantage over the one-course sand asphalt in that it is perhaps possible to obtain a better surface with its use. Any of these solutions would completely eliminate the plane of cleavage of course.

Reconditioned Base, Showing Irregularities in Old Macadam Corrected with Asphaltic Binder

Surfacing Water Bound Macadam With Asphaltic Hot Mixture.—Equally successful, not only in North Carolina, but in many other states has been another type of unusual de- an asphaltic hot mixture on either a new or old water bound macadam. The depth of stone in the macadam after compaction should be not

less than 6 in. If the reconditioning is to be done on all old macadam this will probably resign. This, briefly, consists of a surfacing of quire scarifying the old stone and the addition of new stone to bring the total thickness to the proper depth. The stone is manipulated in the rolling, dusting and sprinkling as in the construction of ordinary water bound macadam. Just prior to laying the bituminous mixture the surface of the stone course is swept clean of dust to expose the top stones to a height of at least ¼ in.

Upon this base, to a compacted thickness of 2 in., is then spread a modified Topeka mixture, closely resembling sheet asphalt in the gradation of the finer particles, and in the proportional relation of the bitumen content to the finer aggregate. It contains from 26 to 29 per cent of stone passing a ⅝ in. screen and retained on a 10-mesh sieve. To confine the mixture during compression temporary wood headers are spiked to the desired width of surfacing. These are moved ahead as the work progresses and the edge of the asphalt surfacing is backfilled in the construction of shoulders.

Reconstruction of Old Penetration Macadam Roads.—One of the best examples of the facile

8 Ft. Straightedge for Eliminating Irregularities in Hot Asphaltic Mixture Prior to Initial Compression by Roller.

nature of bituminous construction in making use of existing road structures is the reconstruction of old and worn-out penetration macadam roads. While conditions in other localities may have required changes in detail the essential features of this type of reconstruction conform generally with the method in use at the present time in North Carolina. As these old roads, almost without exception, are much too narrow the first problem is one of widening. This may be accomplished with the use of either a portland cement or a bituminous black base with equal success. Due to grades

A Joint in the 2 in. Asphaltic Concrete Wearing Surface on Reconditioned Waterbound Macadam. The Surface of the Stone is Swept Clean to Afford Maximum Bond to Wearing Surface

which are extremely broken it is necessary to eliminate the worse irregularities in fitting the new grade line to the old. In doing this it is perhaps better to hold the new line slightly higher than the old as filling in depressions between the new base side strips has proved more successful than trimming down places which are too high. These depressions in the old base are then filled with a rather open binder. It is important to emphasize the necessity for holding this binder course as lean and dry as is workably consistent. This binder course also ought not to exceed four in. in compacted thickness.

After the inequalities in grade between the old base and the new base have been corrected so that the desired base cross-section has been accomplished a 2 in. wearing surface is superimposed thereon. This course may be of either a modified Topeka mixture or sheet asphalt.

This form of reconstruction is capable of transforming a superannuated road into a very serviceable road at a cost much less than that required for entirely new construction.

Asphaltic Surface on Sand-Clay on Top Soil Roads.—These three types—sand asphalt, salvaged water bound macadam, and widened and topped penetration macadam—illustrate adequately, I believe, the widening range of usefulness of bituminous construction in the semi-hard-surface field. In addition a new opportunity for development has sprung up in the need for what might be regarded as of the inferior classes of construction. This need dates from the institution of the Upham policy of progressive type construction and is in itself the acknowledgment of the lack of a suitable surfacing of a type higher than the topsoils and gravels, yet lower than the flexible types of hard surfaces. To meet this need several

constructions have been experimented with, but to date only two of these have been developed to the point of moderate success.

Perhaps the most simple of these is the Upham type, and is accomplished by scarifying the existing sand clay or topsoil road to a 2 or 3 in. depth. Stone uniformly graded from 1 in. to 2½ in. in size is then broadcast over the loose material in a uniform thin layer. Further manipulation by means of harrowing, puddling and machining thoroughly mixes the stone with the top layer of soil. When this operation is completed the stone course is thoroughly imbedded in the soil yet presents a uniform rough surface which will effectively

Top: Sand Asphalt Construction in North Carolina. Below: Finished Sand Asphalt Roadway Near Pinehurst, N. C.

anchor a hot mix surface to the topsoil roadway. Several surfacings have been used in these experiments. Although no extensive mileage has been constructed this idea is certainly worthy of intensive investigation.

Veneer Macadams of Georgia.—A more elaborate and more expensive modification of this veneer idea is found in the shallow macadam surfacings to be seen to good advantage in Georgia. They differ from the Upham veneer in that no attempt is made to keep the semi-flexible surface to the soil subgrade. The surface proper consists of 3 in. of compacted penetration macadam constructed in the usual manner with the exception of the seal coat. After the intermediate size stone have been scattered over the penetrated large stone and thoroughly rolled a mixed seal coat conforming to sheet asphalt standards is placed thereon to the average compacted thickness of 1 in. This mixture provides not only an effective sealing medium but also a very pleasing wearing course as well. Excellent drainage, is of course, a pre-requisite to the use of either of these veneer macadam types. In this connection it is of interest to note that Georgia has enjoyed considerable success with the use of an asphalt or relatively low penetration in not only the veneer macadams but also in the macadams of standard section.

Bituminous Earth Roads.—An extensive and important investigation is also being carried on in the development of a surfacing which might be described as a medium between a veneer macadam and a surface treatment. While the true merit of these asphaltic oil roads has not as yet been positively determined the present indications signify an early success. It consists of a pliable extremely elastic mat built up by successive applications of asphaltic oil on a prepared soil road. Its three greatest advantages are the economy and ease of construction, its protection of the underlying soil road and its dust palliative properties. The present method of constructing this surfacing in North Carolina is as follows: Recognizing the fact that the finished surface will ride no smoother nor will it carry heavier vehicles than the base, great care is taken in preparing the road for the treatment.

All weak places in the surfacing are required with good soil or gravel prior to treating after which the road is subjected to dragging, retaining a crown of from ¼ to ½ in. per ft., until it is thoroughly compacted under traffic. Prior to applying the prime coat all loose material is removed from the road surface by means of machines and street brooms. A specially prepared tar is applied as a prime coat at the rate of 0.3 to 0.4 gal. to the yd. and covered with from 12 to 15 lb. of sand. This sand is uniformly distributed by dragging with sectional broom drags after about 6 hours. This coat is then allowed to set up under traffic for from 5 to 10 days to allow the volatile fractions to evaporate and to get the full colloidal effect of the tar.

All loose sand is then swept to the sides and a specially prepared asphalt is applied at the rate of from 0.4 to 0.5 gal. About 30 lbs. of sand per sq. yd. is used as a blotter for the second coat which is broom-dragged as before.

The asphalt application is repeated from year to year building up a mat of from 2 to 3 in. at the end of the sixth year. Patching and reconditioning are equally easy due to the gradual accumulation of this flexible mat which greatly distinguishes this form of construction from the ordinary oil-treated road—

it has come to be generally known as the bituminous earth road.

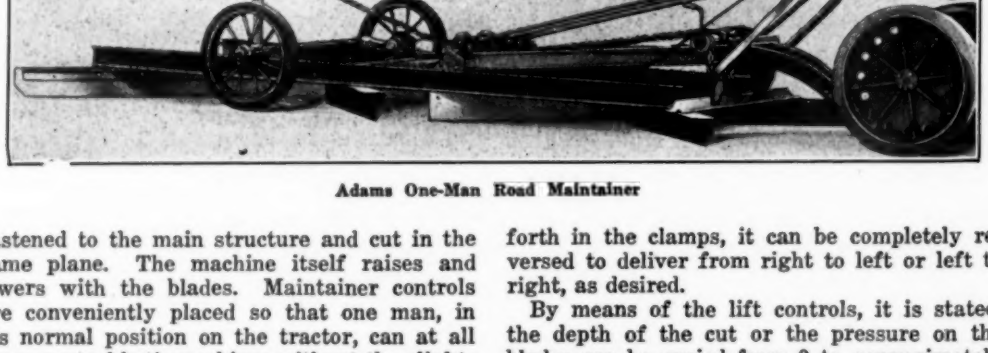
In conclusion this brief examination of the recent developments in the bituminous paving field has attempted to point out the following facts: First, there is revealed an increasing need for more thorough research into bituminous materials and mixtures, and for a closer cooperation between laboratory and field in the presecution of such research; second, the engineering profession and the asphalt paving industry at large are challenged as never before to the improvement of construction methods with a view to economy; and third, the facile nature of asphaltic construction in road design as well as its ready adaptability in reconstruction work are every day attaining more universal recognition.

New One-Man Road Maintainer

A new one-man road maintenance machine having 40 ft. of blades which work the road surface four times has been brought out by J. A. Adams & Co., Indianapolis, Ind. The machine is so designed that it can be easily hitched to any light tractor by means of a simple draw bar and clevis. The tractor is readily available for other work and the maintainer need not be held up for any possible tractor repairs. The blades are rigidly fastened to the main structure and cut in the same plane. The machine itself raises and lowers with the blades. Maintainer controls are conveniently placed so that one man, in his normal position on the tractor, can at all times control both machines without the slightest difficulty.

The Adams one-man maintainer cuts 9 ft. wide. The loose material cut by the blades is worked back and forth across this 9 ft. four times in one passage. In starting operations the operator simply sets the blades to cut the proper depth and with the proper pressure according to the condition of the road. As he proceeds it is an easy matter for him to glance behind to observe whether the machine is cutting deep enough or too deep and any corrective adjustments are easily made without stopping the outfit. It is stated that after the machine is once adjusted to the general contour and condition of the road, very little adjustment of the machine is necessary or desirable.

The maintainer is drawn by a V-shaped drawbar which hitches to the tractor drawbar. The entire structure with the exception of the hinged drawbar and crank type axle, is one solid unit, raising and lowering with the blades. The front end of the maintainer is suspended under the drawbar and is raised and lowered, right and left sides independently, by the two left hand crank controls. The rear end of the maintainer is raised and lowered by the right hand crank control which adjusts the crank type axle. Raising and lowering the machine is accomplished by means of chains which wind on shafts. The three operating cranks immediately back of the tractor seat operate worm and gear mechanisms which, in turn, operate chain winding shafts. The gears are machine cut, close fitting and run in oil in dust proof housings. All blades but the rear one are in fixed position at 45 degrees angle. The rear blade is fastened to each main frame member by clamp brackets. By loosening the clamp bolts this blade can be set in any desired position and by sliding the blade back and forth in the clamps, it can be completely reversed to deliver from right to left or left to right, as desired.



Adams One-Man Road Maintainer

By means of the lift controls, it is stated, the depth of the cut or the pressure on the blades can be varied from 0 to approximately 3,000 lbs. (the weight of the machine), according to the make-up and condition of the road. The rubber-tired, roller-bearing wheels aid rapid and easy transportation of the machine from one location to another. By means of the three controls the entire maintainer can be raised to clear railroad tracks or bridges. An Adams scarifier attachment may be used with the new maintainer, thus adding materially to its range of usefulness.

The Why of Low Prices in Road Contracting

Conditions in the Highway Construction Field Reviewed in Paper Presented Jan. 12 at Annual Convention of American Road Builders Association

By A. R. HIRST

Chief Engineer, American Vibrolithic Corporation, Des Moines, Ia.

Unless an especial contractor has the cards stacked somewhere in his favor, consistent profits from state, county and federal highway work are so precarious that in the long run one has about the same chance of winning that one has if he plays slot machines for a livelihood.

During the past few years tons of good white paper have been covered with exhortations to highway contractors to get together and instruct themselves and their brethern how to bid so that all jobs would be profitable to the successful contractor, Contractors associations have sprung up, lived, or died—their ever motto being "Make the Contracting Business Profitable." Equipment and material companies, technical magazines, and many engineers and their associations have turned their attention to the problem of eliminating the irresponsible, untrained, unfit, under-equipped, or super-optimistic contractor from the field.

Brains and money have not been lacking in the quite sustained effort to improve the conditions under which highway contractors operate. All without apparent results. To one who has been quite familiar with the field of pavement contracting for 20 years, it seems that in 1925 the conditions and prices have been relatively worse than at any time in our history.

Certain contractors have always had certain special conditions set up in certain localities, either by the legitimate use of proprietary pavements, or by the especial merit of their work, or by means which we need not discuss. Usually these contractors make a reasonable profit, because they are masters of their own destiny and by one means or another they have eliminated the suicidal knifing of jobs. The ethics of some of these solutions we shall not discuss. Sufficient to say that every man has a right to safeguard his livelihood and his investment within legal limits. To anyone who really knows the pavement field it must be obvious that the only pavement contractors who consistently make a good livelihood or more, are those who are not thrown into the maelstrom of irresponsible competition on every job they bid.

On the jobs open to the world chaos has ruled. It has been possible for almost anyone to qualify, even where qualification was ostensibly required. There are still scores of angles with more money than brains, who look at the apparently big paving prices and confuse prices and profits. Any foreman or engineer who has laid a few thousand square yards of pavement feels that he is perfectly qualified to bid and build jobs.

The Careful Estimate and the Job.—In case the job is open to the world, not an occasional job, but almost every job is awarded at prices below what even the most optimistic, though sane, contractor could figure as cost, if all the dozens of items which should be figured into cost were really included. Of course, there have been cases, even in 1924 and 1925, where lucky contractors have gotten really profitable contracts as events came out, but these cases are so few and far between that they provide very little brightening to the general picture of great loss, loss, breaking even, or anemic profits.

It does not appear advisable that we should all spend any considerable amount of time and energy in formulating and discussing the real fundamentals and the details of actual methods of estimating the expected real cost of a job, which detail must take in every one of dozens of items which together make up cost, when under present conditions the roughest approximations serve every bidding purpose practically as well. "Estimating the job" is easy. The trouble is that good estimating never gets on except by a miracle. Today when an old timer gets a job he frantically digs over his papers to see just where he made a mistake and dropped out several thousands dollars. Usually he finds it.

I venture the assertion that when the competition was absolutely open to the world in 1925, that in not one out of twenty cases did a pavement job go to a contractor who really estimated with knowledge and intelligence the cost of the job, then added a legitimate profit, and then bid just what his figures showed!

Prices at recent lettings, prices on some recent previous job, the net outcome of which is known, the kind of competition, the time of

the year of the letting, the urge or lack of urge to keep men and outfit going, have had a much larger influence on prices bid than valid estimates of cost plus profit. The best estimators are usually the poorest job getters. A real job getter has to be an optimistic Irishman, putting in his bid on a sunshiny day after he has attended the wake of a deadly enemy the night before.

What is behind all this? Put in a very few words, the cause of the perennially low stage of public pavement contracting is as follows: Competition open to the world with no price advantage given to the well financed, equipped and manned contracting organization which can, will and does furnish a good job, built on time without trouble, as compared to the "haywire" organization whose motto is "Muddle Through" and whose personnel, financing, equipment, progress and workmanship are alike on the narrowest edge of getting by.

Contributing Causes for Low Prices.—Some of the contributing causes for low prices in the highway field are included in the following list:—

1. Open competition with widespread advertisement of jobs.
2. No bonus for speed.
3. No bonus for workmanship or quality.
4. No bonus for freedom from trouble in conducting the job.
5. Materials furnished by municipality in many cases, thus reducing financing required.
6. No preference on materials due to too generous lien laws and bounding protection to sellers.
7. Natural desire of machinery companies to sell their goods to anyone.
8. The number of bonding companies competing for business, some of whom will bond anybody. Many of these companies, when in doubt, increase the competition by bringing in new bidders who will bond with them.
10. The gambling tendency of almost all contractors.
11. Lack of continuous and consistent programs in most areas, leading to a building up of organizations and equipment during the peaks and a wild scramble for the few available jobs during the depressions.
12. General overcrowding of the highway contracting field.
13. General lack of really severe qualification of bidders.
14. The almost universal practice of giving any low bidder a job, provided he can furnish a bond.
15. Irresponsible and ignorant of cost subcontractors who take details of the work from underbidding contractors at even lower prices.
16. Sales of motor trucks by some truck companies to anyone on shoestrings. These shoestring owners, totally ignorant of actual costs, subcontract hauling at far below cost, and give contractors who prey on their ignorance a great advantage over contractors who own their hauling equipment and know what it costs them to own and operate it.
17. The energetic, and usually successful, efforts made by most sellers of pavement materials to bring in low bidders on their special type of pavement whenever several types are in open competition. In fact, this sustained effort of many large producers of materials to lower pavement prices is one of the most serious phases of the situation.
18. Constant introduction of new firms, new blood, and new money, and the seeming necessity that most of these new performers get at least one costly lesson before they settle down to normalcy, or pass out.
19. Desire of politically ruled municipalities to make a low price showing on the actual awards, regardless of the final outcome, which can well be covered up.

The Remedy?—There is none remotely possible, in my humble opinion. The man who can suggest an effective cure for the present evils would deserve from the highways contracting fraternity a reward greater than any man in the construction field ever received.

Low Bid not always Best for Public.—Deep down below this situation lies the state of mind of our whole people. They have been educated to believe that accepting the low bid and a profitable deal to the public are always the same thing. Public officials cannot long hold their jobs if they award to other than the lowest bidder. They cannot "sell" their people the idea that the contract amount is only one factor of both the total cost and the final cost. All jobs look about the same to the public. Most of them cannot distinguish between a rotton job, a fair job, and an excellent job. They grouch about delays and detours, but they grouch just as much about a few days as about many. The common man argues that with everybody bidding on the same plans and specifications and with a surety bond required, the result must be the same whoever gets the job, and that if the contractor fails to perform, the bonding company must finish the job at the original prices.

There is absolutely no general public conception of the fact that with the same plans and specifications the value of the finished product legally delivered may well vary fifty percent, if all factors of time, detours, traffic service, and the quality and life of the pavement are taken into account. In the present public opinion "pigs is pigs," a contractor is a contractor, a pavement is a pavement. The contractor who just gets by is just as good as the one who is a world beater in skill, speed, and efficiency.

The Public and the Politicians.—We will not have a widely different condition in the open field until the general state of the public mind is different—and I doubt whether it can be made to be different.

The public gets most of its education on public questions from the politicians and the newspapers and it would be a brave politician or newspaper who would undertake any sustained campaign to raise the apparent cost to the public of public construction enterprises. Few engineers or public officials are brave enough to face the public wrath and the suspicion of grafting which always comes from an award to other than the lowest responsible (Heavens, how that word "responsible" can be stretched!) bidder. If contractors, material or machinery companies, bonding companies, or their associations publicly urge better prices to responsible contractors only, the average man says—"Ha! Of course they would advocate high prices, it means more money in their pockets." Intelligent striving for betterment is stopped at every turn, has been for years and will probably continue to be as long as human nature continues to be the same, and human nature is almost a constant.

There has been a quite sustained and intelligent effort made in the last two years to improve the situation by providing for the real qualification of bidders, either in advance of the bidding or before an award is made. S. M. Williams, of the Autocar Co., has probably done more than any other one man to promote this much needed reform and a considerable advance is being made. However, on public work, so many exceptions can be made, have to be made, and are made, that the value of apparently rigid qualifications is nowhere fully attained. The semi-political atmosphere in which most public work is conducted is not conducive to the exercise of uninfluenced judgment of facts, even where the awarding body has the best intentions.

What Happened to an Adequate Cost Sheet.—Little has been said about "Estimating The Job"—I am not going to say much. Years ago I was instrumental in having made up and published by the Wisconsin Highway Commission in cooperation with contractors and machinery and material men, a quite adequate cost sheet to be used in estimating the cost of rural concrete road projects. This sheet was much circulated and copied but has about disappeared from the field because it was really quite complete and contractors found that if they filled in all the items with intelligence and then bid the figures the sheet gave them, they never did get a job. They ceased to be contractors and became gentlemen of leisure.

I imagine the reason why there is little of this kind of information available now and why contractors organizations have not devoted themselves to the task of formulating more adquate cost sheets, is because no one can use them. In preparing this paper I did a lot of work preparing cost estimating sheets but the results were so appalling and the answers gotten so at variance with prices bid that my work went into the waste paper basket.

If a contractor is going to stay in the open field of pavement competition, about all he needs to estimate with is the current reports of recent previous awards in the area; a knowledge of who is going to bid; a Ouiji board; a rabbit's foot, and a good bank account.

When Conditions Will Improve.—Someone says, "stop kidding us and give us something constructive tending to eliminate the present evils." Well, if you must have it!—Conditions will be improved when most of the nineteen previously listed causes of the present conditions are partly removed or totally eliminated.

Highway contractors are, many of them, in the game to stay. They have to be, because their all is tied up in it. They play the game because it is the only game they know.

Most of the good contractors have pulled through so far and they will probably continue to pull through until they get the final trimming which is almost inevitable if they bid so as to get jobs in the present market. The Lord does love a contractor, but the Lord also loves those who help themselves. It is up to the real highway contractors to really start something that will help themselves Just what, requires deep consideration by the wisest heads. Certainly nothing so far started has resulted in anything which has very greatly helped the situation. Obviously, before there can be any general relief many different kinds of people, all factors in the situation, must be educated. Education costs money and takes brains on both ends of the line. Above all, the whole public must be educated. That takes national advertising, and national advertising costs real money.

In my opinoin, the interests which should be allied to contractors have not co-operated as they should to improve conditions, but on the contrary, many of them have materially helped to make them worse. They should help in removing from it the unfit and disturbing elements by refusing to accept their business.

In conclusion, it is my impression that there is no collective way out of the present morass which can possibly give immediate results. Small groups of contractors can, in many cases, work out individual solutions for limited areas which will give immediate relief. Any real result can only come with the elimination of irresponsible competition in the area. As long as the competition is open to the world with the

awarding body taking into account nothing but the prices bid, there can be no adequate reward for competent service, workmanship, speed and value of product. In my opinion, the really competent and able contractor who stays in the wide open public contracting field is wasting his time and his talents and is unfair to himself and to his dependents.

To reiterate, the answer is not collective. It is individual, and each contractor or group of contractors must work out the answer in their individual area. The sooner good contractors stir themselves to find this individual answer the more money they will have with which to escape the poorhouse, if 1924 and 1925 have left them anything more than their happy dispositions.

Improvements in Heil Hoist Design

Some important changes in the design of the Heil Hoist that are stated to make possible higher dumping angles, reduce weight and do away with all oil troubles, have been announced by The Heil Co., Milwaukee, Wis. The cut shows a Model 4S-26 hoist mounted on a 3-ton truck. The application of power is direct. The hoist swings on its saddles. The gear pump in the manifold developes the pressure and forces the oil down the oilways on the front of the cylinders and under the piston head. This pressure raises the load. As the piston rods move out of the cylinders a supply of oil from the oil reservoir is required to take their place. This oil reservoir is now cast integral with the hoist cylinder replacing the sheet metal tank and connections. This construction prevents all possibility of oil tank leaks. The elimination of the sheet metal tank gives the new 1926 models a more finished and clean cut appearance. The removal of the tank permits the servicing of any part of the hoist without the necessity of removing any other part not requiring service.

The head of oil in the reservoir is now below the piston rod gland nuts instead of above preventing all possible chance of oil leaks around the piston rod. This together with the elimination of the oil tank will keep the hoist clean and free from oil accumulations. There is positive equalization of oil between cylinder reservoirs through an equalizer tube, eliminating the possibility of drawing air into the cylinders.

The oil is now drawn into the pump through the opening in the rear of the cylinder, then through an oil passage around the inner side of the cylinder. Because the oil opening is at the rear of the cylinders the tilting of the hoist in raising assures a positive flow of oil to the pump at all times, thus eliminating the churning of oil. The distance between the piston head and the cylinder head when the hoist is in extreme raised position has more than doubled giving a better support and greater rigidity to the piston rod.

The oil capacity of the new style 4S-26 Hoist is 16 qts., whereas the oil capacity of the old 4S Hoist was 20 qts. All other models have been reduced in proportion. The weight of the hoists filled with oil has been reduced from 20 to 40 lbs. a very important amount for haulers in certain states.

Model 4S-26 Heil Hoist on 3-Ton Truck

The piston stroke has been increased 2 in. on Model 4S-26 as well as on other models. This increases the dumping angle approximately 5 degrees as well as increases ground clearance.

A cylinder head strut between cylinder heads can be used in place of the link bar making the hoist easy to mount. The hoist frame still remains 36 in. long and gives 6 in. greater adjustability for body installations. A combination fill and air vent on the cylinder heads prevents the body from back tipping.

Highway Maintenance in Indiana

Work of State Maintenance Division Reviewed in Paper Presented Jan. 20 at 12th Annual Road School, Purdue University

By A. H. HINKLE
Superintendent of Maintenance, Indiana State Highway Commission

Six years ago the Indiana State Highway Commission took over a system of road afterwards known as state highways. To comply with the law, this system of roads reached every county seat and every town with more than 5,000 population. After the roads were designated as state highways, the state became responsible for their construction and maintenance, including the bridges, guard rails, marking and signing and other features required to produce and maintain a system of highways that would satisfactorily and safely carry the traffic.

The development that has taken place on this system of roads in the short period of time is very marked. Although some of the roads taken over were in very good condition and have not been changed much, this can not be said of a larger part of the mileage. Many of the roads taken over in the sparsely settled district were trails. Few through routes were suitable for traffic during the good season of the year and practically none were passable their entire length during the winter, spring, or early summer.

The Construction Division has paved nearly 1,000 miles of roads. The bad gaps in the through routes have been improved with stone or gravel when not paved. The narrow roads have been widened. Continuous maintenance throughout the year has been maintained on practically the entire system. As a result we have a system of about 4,000 miles of state road that are not only passable throughout the year, but are for most part in excellent condition much of the year. This transition has been brought about in the fact of an increase of traffic during the six years of 100 to 200 per cent. Some districts in the state have been opened to a method of transportation that is developing them rapidly.

We have usually gauged our field men by the condition in which they kept their roads. This was the greatest stimulus for maintaining a good road. The experience of some of our men and even hardships suffered by them in the first years of the work are hardly known. One may learn of these best while chatting with them as soldiers do, who narrate their experiences about the campfires.

Organization of the Division of Maintenance.—When the Division of Maintenance was organized in the early part of 1920 there were five district engineers and 25 superintendents. The road mileage in the state systems has increased and our organization has increased to take care of this mileage until we now have 6 district engineers and 32 superintendents. The organization has remained constant since 1923. On Oct. 1, 1925, our records showed that we were employing 60 foremen, 247 patrolmen, 266 teams with drivers, 41 skilled laborers, 28 tractor operators, 454 truck drivers, 964 common laborers, 13 roller operators, 7 miscellaneous positions, or a field force of 2,134 men. This does not include the mechanics and their assistants in the local garages, as these are carried on the motor transport payrolls.

The division does much of its work by contract and the percentage of such work determines the number of employes carried on the state payroll. During the rush period in the late fall and early winter of 1920, we had nearly 5,000 employes on our payroll. This rush of work was brought about by the delay in our new organization getting under way, and also because of the demand to put as many roads as possible, that had just been taken into the state system, in passable condition for the winter and spring season.

Miles of Road in the State.—The work done by the State Highway Commission in the past six years is shown in a general way by comparing the lengths of different types of surface in the state system when taken over by the whole department and with lengths now. (The comparison shows the work accomplished by the whole department and not merely that of the division of maintenance):

	Miles when taken over	Miles Jan. 1, 1926
Brick	41.0	68.6
Cement concrete	96.7	933.8
Bituminous concrete	7.5	26.0
Bituminous macadam	24.0	172.8
Surface treated macadam	68.8	23.7
Stone	796.1	999.7
Gravel	1,892	1,629
Earth	264.7	60.9
Miscellaneous	.....	20.8
Totals	3,191.5	3,935.3

We have recently compiled the lengths of all types of roads in the state by county, and further classifying them as state, county and township. This is the most complete report on the lengths of the several classes and va-

rious types of road that has ever been compiled. We might say that it is the only complete report of its kind that has ever been made.

The tendency seems to be for the counties to take over more, if not all, of the township roads. While one of the incentives for this is to get a greater portion of the gas tax, this transition will no doubt result in better and more economical road maintenance in many of the counties.

From the point of view of convenience and accessibility, the county is now not as great as the township was 50 years ago. This same comparison might well be made between the county and state. Fifty years ago, to go from the average county seat to the far corner of the county by horse drawn vehicle, took as long as it now takes to go by auto over the state roads from the state capitol to the border of the state.

This is only another way of saying that the world is getting smaller from a transportation point of view. Some one has rightfully said that the average man's sphere of acquaintance has within the past 15 years increased from 10 miles to 100 miles.

For those reasons the state should no doubt take over more miles of the county roads. The federal highway law permits federal aid on 7 per cent of the roads of the state. Our new compilation of all roads of the state shows a total of 73,111 miles. This would permit federal aid on 5,118 miles. Certainly this is the minimum that should be in a state system. However, the larger the mileage that is maintained, the less the paving that could be done each year. This factor must be recognized in considering the greater mileage.

Activities and Responsibilities of the Division of Maintenance.—The activities of the division of maintenance are many and varied. One who thinks casually of road maintenance seldom realizes the great variety and classes of work carried on today to maintain a state wide system of highways, in safe and suitable condition for traffic all seasons of the year. Of course, the large part of the work consists in keeping the road surface smooth and suitable for traffic. However, some of the other work is quite as important, if not on such an extensive scale.

The gravel and stone roads must be coated with metal and systematically dragged; the cracks and joints in the concrete and brick roads must be filled with bituminous material; small holes and depressions in these two types of roads are patched with the same kind of material; parts that are broken through to the base must be replaced with new concrete; the bituminous roads are patched with bituminous material and maintained with surface treatments; shoulders and ditches must be sodded and maintained; ruts along the edge of the pavement filled with stone, slag, or gravel; weeds and grass must be cut; snow must be removed from the surface to make it passable for winter use; the drainage systems, both surface and underground, must be kept free from obstructions so they will operate; old and narrow culverts must be extended or new ones of proper length installed; and the old steel bridges must be re-floored and repainted from time to time. As features of safety, to take care of modern traffic, guard rails must be built and maintained; these, together with headwalls and other obstructions along the road, should be painted white, or white washed from time to time; narrow fills must be widened; sharp curves reduced; and, last but not least, an effective system of signs and markers installed to guide traffic and aid in preventing accidents. No small part of the responsibilities of road officials is the keeping of the right-of-way clear of undue encroachment by the property of public utilities, such as poles, tracks and other obstructions which are frequently erected so close to the traveled way as to be a great source of danger. A constant warfare must be waged against oil pumps, filling stations, hot dog counters and fruit stands, which are continually installed too close to the traveled way. They are a source of great danger because of insufficient space in front of them to accommodate parked machines without interfering with traffic.

It will thus be seen that the work of a highway maintenance organization is not merely the dumping and spreading of gravel, as one high official ignorant of road work, one time expressed himself. If the road maintenance organization is doing its duty, it must function in all the above features. While it is all the time looking in one direction, fighting for its rights which are the rights of the citizens, it must at the same time be looking in the other direction, showing a glad hand and a friendly smile to that ever complaining class of citizens who think the highways are not in such good condition as they should be even though they themselves have never done a single act in all their lives that contributed to the provision or upkeep of a better road.

The responsibilities of the county highway superintendents, in maintaining a system of county roads, involve not much less difficulty than the maintenance of a system of state roads.

Work Accomplished by the Division of Maintenance in 1925.—The work of the maintenance division is distributed over about 4,000 miles of road and is continuous over this mileage throughout the year. Hence, this work is so scattered that the average citizen does not realize that the total aggregate of work done is so large. This is best brought home to us

when we examine a summary of the work done, materials used, etc.

Our records show that during the past year, besides maintaining the entire 4,000 miles of state roads and bridges thereon, this division completed the construction of:

24.9 miles of bituminous Macadam;

19.9 miles of stone road on an earth foundation;

9.3 miles of gravel road on an earth foundation;

and rebuilt—18.3 miles of old road as a new gravel road;

and rebuilt—66.6 miles of old road as a new stone road.

In the regular routine of maintenance work 106.5 miles of road were given a surface treatment of bituminous material.

During the year this division constructed 61 new bridges, also slab top and box culverts; installed 474 new pipe culverts; 48 box and slab top culverts, and 231 pipe culverts were extended. Nearly 4½ miles of guard rail were constructed; 80 temporary bridges, aggregating a length of nearly ½ mile, were built to accommodate traffic around bridges under construction.

During the year the division used nearly 1,500,000 tons of stone and gravel, ⅞ of a million feet of lumber, 1,250,000 gals. of bituminous material and 3¾ miles of culvert pipe.

The following is a statement of the expenditures incurred by the Division of Maintenance since its creation:

SUMMARY OF TOTAL EXPENDITURES FOR 6 YEARS ENDING SEPT. 30, 1925

Paid out during fiscal year

Year	Miles Maintained	For Maintenance	For Construction	Total
1920	3,200	$ 836,380		$ 836,380
1921	3,200	2,361,300	$1,809,499	4,170,799
1922	3,280	1,641,761	824,247	2,466,009
1923	3,819	2,096,048	863,043	2,959,091
1924	3,916	2,579,251	1,356,729	3,935,981
1925	3,944	2,127,774	1,647,617	3,775,391
Aver. for 6 yr.	3,560	$1,940,419	$1,083,523	$3,023,942

New One-Man Power Patrol

A new one-man power patrol grader with detachable power unit for general road maintenance purposes is announced by the Stockland Road Machinery Co., Minneapolis, Minn. This machine was built according to specifications developed as the result of an extensive questionnaire on the power patrol problem, to state, county and local highway authorities, and was exhibited at the recent Good Roads Show at Chicago for the first time, International and Fordson tractors being used to demonstrate power take-off features.

The new grader is pulled not pushed. The grader detaches from the tractor, saving the purchase of an extra power unit if the buyer already has a tractor. Power from the tractor, controlled from the operator's seat, raises and lowers either end of the blade and raises and lowers the scarifier. The operator has every control right at hand. It is stated the entire outfit—grader and tractor—can be turned in 20 seconds on a 24 ft. road.

Mechanical specifications of the grader only follow:

Weight, 4,100 lbs.; length of blade, 8, 10 or 12 ft.; arc of blade, 19 in.; width of blade, 16 in.; thickness of blade, ½ in.; blade lift above ground, 12 in.; circle drawbars, 1 in. x 3 in.; high carbon; frame, 6 in.; 15.5 lb. channel; height above ground, 48 in.; lifting arms, 2 in. rd. tool steel; connecting links, 1½ in.;

Stockland Patrolmobile Grader

rd. tool steel.; rear axle, 2 in. square; wheel bearings, Hyatt heavy duty; tread, rear, 69 in.; wheel base, 12 ft. 3 in.; lateral shift, 15 in.; circle lateral shift, 16 in.; scarifier, block type; circle diameter, 55 in.; circle weight, 350 lbs.; rear wheel diameter, 32 in.; rear wheel tire width, 8 in.; rear axle length, 6 ft. 10 in.

This machine is equipped with cut gears which run in oil tight housings. All bearings are babbitted and equipped with take-ups at the wearing points. The wheels are provided with Hyatt heavy duty speed bearings. The grader is operated by a mechanical power take-off of the tractor.

The Patrolmobile grader is designed for any of the road tractors from a rating of 8 H. P. to 12-20 tractors. Each tractor requires a different hitch item to the grader, but such tractors as the International, Fordson, Twin City, are fitted for this equipment.

Road Types on Lincoln Highway.—The various type of road composing the 3,142 miles of Lincoln Highway are as follows:

	Miles
Concrete	559
Brick	117
Asphalt	11
Macadam	449
Graded Gravel	1382
Natural Gravel	33
Graded Earth	333
Natural Earth	34
Paved City Streets	224

Keeping a Highway Organization

Suggestions for Bettering Conditions of Highway Engineers Given in The Professional Engineer

By R. H. HARRISON

Much time has recently been spent in inducing engineering graduates to enter the highway engineering field; a great deal less consideration has been given to satisfying them and keeping them after they have entered the field. In the spirit of the times, the reader's first thought is probably that this is a plea for more money for engineers. In a way it is, but anyone who comes in contact with enough engineers to know them as a group, knows that the money question is not held by this group as a primary question in life. However, it should be listed among the things which hold, and a salary which will compare favorably with the salaries of men of equal education and abilities in the other professions, should be paid.

What, then, are the points that after a very short time influence the young engineer to discontinue highway engineering to take up contracting, salesmanship, life insurance, or the like? The writer believes that in a great majority of cases there are two causes; first, unsatisfactory living conditions and second, thwarted ambition.

Living Conditions.—Living conditions for the engineer have always been rather irregular. Practically every one of the older engineers can sit down and tell heart-rending experiences of camp life, moving, losing jobs, and many will say that the younger generation should go through the mill. But the question is—will it? Things have changed. Comparatively few engineers were needed in those days and the men in the game were for the most part the adventurous, roving kind; today so many engineers are needed that this kind will not meet the demand. Today the young engineer is told to move to a certain town. Every house, almost every room, in the town is filled; this is the condition of nearly every village, town, or city in the country. If he moves, all home life is swept aside; if he leaves his family, there at once comes the thought that absence from home must have some compensation. There is very little trouble in finding a salesmanship job paying double his former salary. There are many engineers today living with their families under almost squalid conditions, and others who do not get to see their families more than twice a month; the parallel is that in these same organizations there are numbers of them resigning every year.

What's Ahead?—Every worker must see something ahead. Highway engineering is a rather precarious profession at its best, due to the public nature of its duties and thus its admixture, more or less, with politics. However, each year gives hope of improvement along this line, and it seems queer that the highway organizations themselves are in many cases the ones which dim the ambitions of their younger men. The engineer cannot go along for years on the same level, knowing there is nothing a little higher up to which he may attain. If he is a good man, one worth keeping, he will get out where he can climb, or at least where there is a chance. If his eyes are on the level and not upward, he will lose his spirit.

The highway field needs experienced men in all of its work from the top to the bottom, and if we are not to fail in the great work which we are carrying on during this decade and the one to follow, we must have these experienced men. They should be in every civic organization having to do with highway construction or maintenance. How are we going to keep these men who are leaving? How are we going to remedy the conditions which are causing them to leave in many places? The writer believes that organization is the answer. Through organization, subdivide the work to be done so that there will be more permanence to positions, and hence more permanence to living conditions, and, of most importance, provide stepping stones by which the men can advance as they improve.

The State Highway Organization.—Highway organization in all civic divisions may be built in essentially the same way, but the one which controls to a great extent the highway programs of today is the state highway organization, as it not only supervises a great quantity of the work done, but exerts an influence on all other highway organizations, both by its contact and by its feeding men into the latter. Therefore, it seems fitting that it should be taken as an example to show how a good organization will maintain itself.

The head of the state organization may be either one man or a body of men and this head necessarily becomes the link between the civic side of road building and the engineering

side. It may well be occupied by an engineer, but not neecssarily so, as strictly engineering features should not come within the province of its duties. The position should be considered distinct from the engineering organization as it is rarely filled by promotion.

The chief engineer should be the next in line with absolute authority over all engineering features connected with the construction and maintenance of all roads and bridges which the state handles. There is a reason for this directly in line with this article, apart from the good effect on the organization through coordination of all the work. This is, that it gives a central authority who is empowered to shift a man to the work for which he is best fitted—road construction, bridge construction, or maintenance. Without this combining of the various types of work throughout the organization in a central authority over all, many men who are excellent on one class of work are buried in a class which they dislike and for which they have no aptitude.

Under the chief engineer there should be a central organization and a field organization, the latter reporting to him through the central organization. The central organization staff should be composed of the construction engineer of design, maintenance engineer, bridge engineer, and possibly one other engineer in charge of special functions. These men should be in direct charge of their work, ranking practically the same, but on a distinctly higher level than the field men for reasons which will be explained later. In an organization with a large program ahead, it will, in many cases, be necessary to have primary assistants to these men, and in this case these assistants should be slightly higher than the field men. The remainder of the office organization should be stepped down to provide for advancement to some extent.

The group of engineers in the main office is generally small and the men do not have the problems confronting them that the field engineers have. They are usually settled, take a part in local interests, and, last but not least, are under the direct eye of their superiors who reward good work by advancement.

The Field Organization.—The crux of the matter of keeping the younger engineer and building an organization which will supply itself from its own ranks is the condition of the field force. Is it in touch with the central office? Is the central office in touch with it? Do they understand each other's problems? In many cases they do not, and the reason is poor organization. After careful study of a number of systems, the writer believes that the so-called district field organization is the only system which even approaches the solution of the problems encountered. The district is the molding place for the heads of the central organization. The district engineer is the chief engineer of his district and is designing engineer, construction engineer, bridge engineer and maintenance engineer for his district. He is getting the experience which will make him available for one of these positions or for that of assistant to one of them in the central organization, and these latter positions must be attractive enough to be desired by a district engineer, for a district engineer who does not care to go further up is a drag. But the greatest experience obtained by the man is executive experience. He learns to control men, to write letters, to make decisions, to look after paper work, to be tactful in his dealings with public officials and with the people—an excellent training for his future greater responsibilities.

However, the responsibilities of the district engineer are far from small. In fact, the greatest drawback to this system is the giving of too much work and too great a responsibility. But this may be remedied, first by making slightly smaller districts than many states have had in the past, and second, by a better contact between the main office and the field forces through more numerous inspections by the staff engineers.

All engineering features which the chief engineer handles should again converge in the district engineer. The good obtained by this is that it carries out the power of the chief engineer to shift his men to the best advantage, and it is through the district engineer primarily that this power functions.

In the district organization the various phases of highway work are again divided and the district engineer should have several assistants—a road construction assistant, a maintenance assistant, and a bridge assistant. Their duties will be quite well defined, but the fact that they are thrown together, talk over each other's problems, and often make an inspection for one of the other assistants, broaden these men to such an extent that they are capable of taking over the position of district engineer when the chance comes. They will come in contact with some of the executive work which will be very helpful in higher positions.

The District Office.—This nucleus in the district office is in much better shape than would be the case without a district organization. It is necessary for the engineer to be away from home part of the time, but in any case there is a home, and an all-year home—not one to be broken up with the passing of each season. He is better able to give his thought to his work. He is able to keep in touch with local matters, to take his place in civic affairs and to feel that he is worth while. He sees ahead of him a place to which he may

advance by perseverance and knows there is some one higher who keeps in touch with his work.

The problem of the man on the work, the resident engineer or the maintenance superintendent, is the greatest, but it does not seem so great to him if he can see something ahead, a position of assistant district engineer where he will be able to settle down. The discouraging thing for the young engineer is not to be able to see a stopping place in this continual moving, generally at his own expense.

But much may be done to make life easier for him while he is still in his present position. A well chosen location will often allow his remaining in one place for two or more seasons, and the choosing of locations and placing of engineers may well be given considerable thought by the district engineers.

Inspectors and members of survey parties cannot be classed with other engineers, generally speaking. They must move, at least within the borders of the district, and quite often about the state. Fortunately, a great majority in these classes are single and are glad to change locations often. Furthermore, it is good for the organization for them to get familiar with conditions in more than one locality. They will profit greatly by the things they come in contact with in the various communities, and will be better equipped to take up higher work. The fact that they see something more or less permanent ahead will increase their zeal in their work.

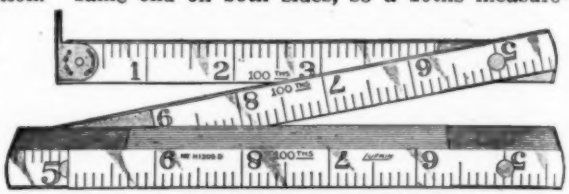
These younger men are helped a great deal in their attitude toward the organization by their contact with the district engineer and his assistants. In the first place, they gain by the older engineer's experiences and in the second place, they feel that a superior is close enough to observe and reward good work.

This state organization plan, with slight modifications to fit local conditions, is adaptable to any state, and, in general, the district organization will fit a county's needs. Experience has shown that the states and counties which now have this form of organization have a much smaller turnover of engineers than those not having it. It is, therefore, urged that the plan be adopted in some form by all civic divisions, with a view of keeping the good engineers and building an organization from within.

Grade Crossing Elimination.—In 1923, the latest year for which statistics are available, the railroads eliminated 972 crossings at a cost of about $100,000,000. During the same period 3,065 new highway crossings were constructed.

Aluminum Rule in 100ths of Feet

A folding aluminum rule graduated in 10th and 100ths of feet is now offered by The Lufkin Rule Co., Saginaw, Mich., supplementing its established line of aluminum rules in inch marking. The 10ths rule is designed to meet the needs of civil engineers, surveyors, highway builders and tile layers, and will appeal to others in related lines of work. As its opposite side bears the common graduation, feet, inches and 16ths, the rule is suitable for all ordinary measuring. Graduations begin at same end on both sides, so a 10ths measurement can readily be converted into terms of inches, and vice versa. This new rule is made in 6-ft. length with 6-in sections. It can be supplied either with or without folding end hook. This hook is just the thing for taking measurements out of arms reach and handy in all measuring. It readily folds up and remains flush with edge of rule. Zero point falls at inside of hook when open, and at extreme end of rule when hook is closed. These aluminum rules are of a special hardness, therefore, hold their shape well. The dark sunken graduations show up distinctly. While very durable, the aluminum rule is light weight. It is accurate, and, having solid brass joints, is rust proof throughout.



New Folding Aluminum Rule

17,589,000 Horses in U. S.

According to an article by W. M. Jardine, Secretary of Agriculture, in the March-April issue or The Military Engineer, on Jan. 1, 1925, there were on farms 17,589,000 horses and 5,411,000 mules, which is a decrease of over 2,000,000 horses, or 11 per cent since Jan. 1, 1920. The mule situation has remained practically constant. Of the horses on farms at present, it is estimated that the average age is 9.8 years; that 43 per cent are over 10 years of age; 45.6 per cent are between 4 and 9 years of age, and 11.4 per cent are under 4 years of age. Of the latter group, 5.3 per cent are 2 years old and under, while the 1920 census shows that this same group made up 12.8 per cent. If the horse-colt crop during the next five years are no larger than in 1924, at the end of that time there will be only 659 head of horses for each 1,000 head at present.

Cost of Hexagonal Slab Concrete Pavements

Some Data on the Construction of a New Design of Pavement at Longview, Washington

By L. A. PERRY

Construction Engineer, The Longview Co., Longview, Wash.

It is perhaps natural that novelty in design of any structure, regardless of its structural merit, should meet with the disapproval of the average contractor for the reason that construction costs are vitally important to him and anything new or unusual has the appearance of being more difficult to build, even though it may be actually easier. Since this is more or less true of the hexagonal slab design of concrete pavement, the purpose of this article is to discuss certain steps of the construction operation bearing upon progress, and to record statistics of work in this city involving the new design.

The fact that the hexagonal design is in many cases easier to construct than the so-called standard designs will not be appreciated without careful consideration of some of the various progressive steps of the construction operation.

Comparison Between Standard and Hexagonal Design.—To make a comparison it will

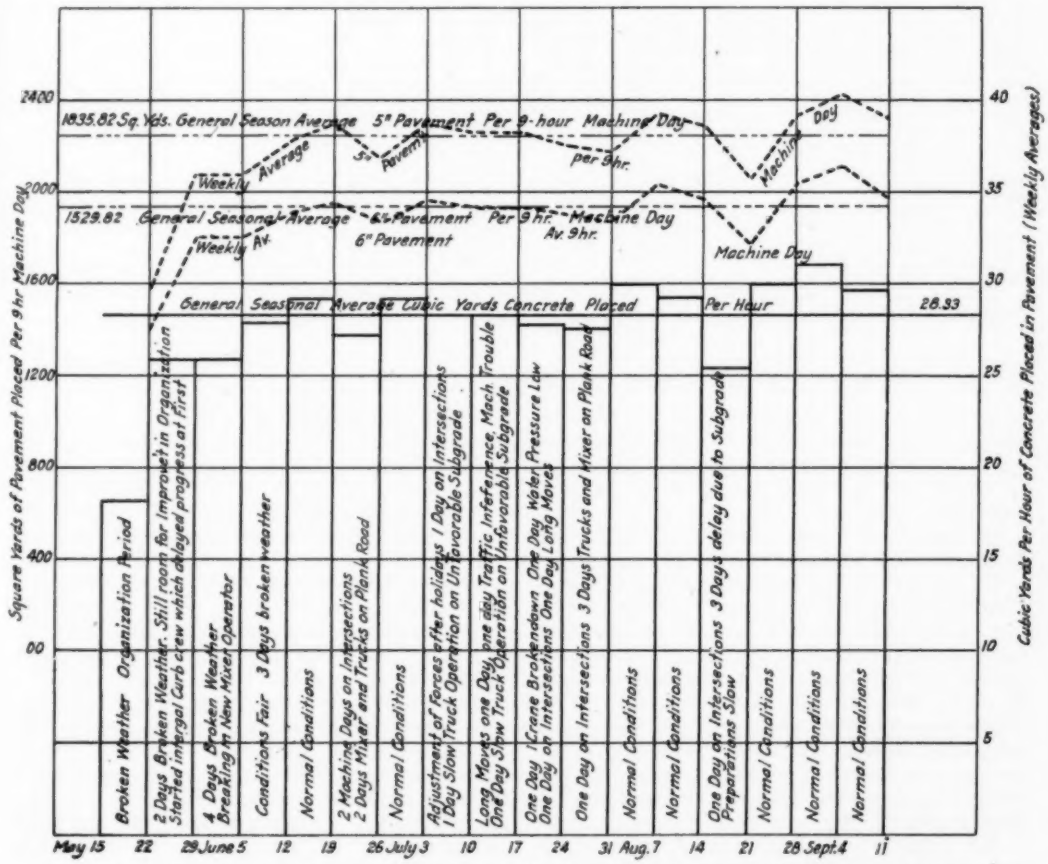


Fig. 1—Graphical Record of Seasonal Progress in Construction of Hexagonal Slab Concrete Pavement

be necessary to assume some typical standard design, whose uniform slab area per unit of expansion joint material is equal to the hexagonal design. For this purpose probably no design will serve better than that of the excellent concrete pavements built by the Washington State Highway Department, having complete transverse joints at 20 ft. intervals and a straight longitudinal joint, making each slab 10x20 ft., compared with a hexagonal design, as illustrated in Fig. 1, Page 1243 "Roads and Streets" of Dec. 2, 1925, having staggered transverse joints at 17.32 ft. intervals connected with 10 ft. centre joints.

It will be remembered that all joint material must be placed between the mixer and the operation of deposit. It is most important that (1) the joint strip be placed expeditiously to avoid delay to the general operation, (2) that off of the centre line. The joint setters body will be from 3½ to 4 ft. away from the boom in centre position and even in the event the boom is swung to his side his body is in a safe position and he proceeds to "peg down" the joint intersection with dispatch, and without involving hesitance of the mixer operator. With the standard design, the length of longitudinal joint is 20 ft. It occurs that a "flop" or "bellying" of the long "wet joint" if allowed to exist would tend to pull the free ends of joint material away from the intersection, causing imperfect jointing at corners. The alteration necessary to obviate this effect is manifestly greater with a 20 ft. "wet joint" than with one only 10 ft. long, and with the hexagonal design the centre joint lies in such a position that the weight of plastic concrete against it tends to hold the joint material over

Table I—Seasasonal Progress of 5-Sack Paving Mixers in Weekly Averages

Week Ending	Total Wecks Progress Cu.Yds. Concrete	Machine Days	Average Daily Progress	Average Hrs. Per Day	Avg. Progress Per Hr. Cu.Yds.	Equiv. Prog. 6" Pave. Sq.Yds. Per Hr.	Equiv. Prog. 5" Pave. SqYds. Per Hr.	Equiv. Prog. 6" Pave. Sq.Yds. 9 Hr.Day	Equivalent Progress 5" Pavement Sq. Yds. per 9-Hr. Day
May 22	399	3	133	7.333	18.138	108.83	130.59	979.47	1175.31
May 29	982	8	196.5	7.60	25.85	155.10	186.12	1395.90	1675.08
June 5	905	4	226.25	8.75	25.85	155.10	186.12	1395.90	1675.08
June 12	1608.7	7	241.0	8.643	27.88	167.28	200.73	1505.52	1806.67
June 19	3023.13	12	251.91	8.682	29.05	174.30	209.16	1568.70	1882.44
June 26	2404.9	12	200.4	7.38	27.15	162.90	195.48	1466.10	1759.32
July 3	2510.57	10	251.06	8.60	29.19	175.14	210.16	1576.26	1891.44
July 10	2297.81	10	229.78	8.10	28.37	170.22	204.26	1531.98	1838.34
July 17	2891.00	12	240.92	8.50	28.34	170.04	204.05	1530.36	1836.45
July 24	1946.11	10	194.61	7.00	27.80	166.80	200.16	1501.20	1801.44
July 31	2785.48	12	232.12	8.42	27.56	165.36	198.43	1488.24	1785.87
Aug. 7	2051.63	9	227.96	7.61	29.95	179.70	215.64	1617.30	1940.76
Aug. 14	2363.56	9	262.63	9.00	29.19	175.14	210.16	1576.26	1891.44
Aug. 21	2570.11	12	214.17	8.42	25.45	153.58	183.09	1373.22	1647.61
Aug. 28	2474.05	11	224.91	7.50	29.98	179.88	215.85	1618.92	1942.65
Sept. 4	2757.70	12	229.80	7.42	30.97	185.82	222.98	1672.38	2006.82
Sept.11	1563.97	7	223.42	7.57	29.51	177.06	212.47	1593.54	1912.23
Total	35834.71	157	226.34	7.99	28.33	169.98	203.98	1529.82	1835.82
								Actual Avg. including broken days	Actual Avg. including broken days
	35834.71	157	(Actual Average per day including fract. days)					1358.04	1629.64

when placed it does not readily become displaced so as to involve unnecessary finishing labor. (3) That the centre joint when finished be straight as possible and present the best general appearance.

Advantage of Hexagonal Design.—To see the practical advantages of the hexagonal design, it must be borne in mind that with the standard design the intersection of transverse and longitudinal joints fall on the centre line, which is the general path of the bucket at a point near the paver, and that the joint is always set snug up behind the machine. This means that the joint setter, if a careful workman, will watch the bucket movement and govern his actions accordingly, entailing one of the many minor delays which accumulate through the day, and must effect the progress of the machine. In laying the hexagonal design, the actual joint intersection falls 2½ ft. against, or butted up to the end of the transverse joint. This is done by having the centre joint material stapled not less than 2 ft. from the corner.

The greater ease with which a section of longitudinal joint 10 ft. long can be held in alignment with good general appearance than that of a joint section 20 ft. long will be evident to anyone.

With the standard design, employing dowels for interior corner protection, the expansion joint material cannot be pulled or otherwise moved after once having been set, due to the fact that the dowels extending through the joint material form anchorages. This restricts the use of finishing tools to one slab, or pair of slabs, at a time, since the joint must be left high for edging and trimming. With the hexagonal design, however, where corner protection is provided without resort to dowels or

shear bars, the joints are embedded or submerged allowing the unrestricted use of all finishing tools, the joints being pulled afterward with tongs. In this way finishers get a "clear sweep" at the surface, and a much better finish can be obtained. It is also important to remember that aside from the cost of dowels or shear bars in the standard design, the placing of them, especially if done correctly and if held in true position, is an addi-

of 6 in. and 5 in. pavement. This record is representative of the entire paving program in this city for the season. It is the writer's belief that no record exists showing a better seasonal average progress on strictly city street work than this. In this connection it must be remembered that the occurrence of street intersections, monuments, sewer inlets, valve chambers, telephone and other manholes and other underground structures retard prog-

Table II—Progress Report and Cost Analysis of Best Day's Progress

INSPECTOR'S DAILY REPORT

L. I. D. No. 5 (CITY OF LONGVIEW

Day Monday Month August Date 31 1925

Crew	Foreman	Item	Progress	Location	Labor Cost	Material Cost & Inc.	Remarks
PAVING	REARDON	6" Pavmt. sq. yds.	2100.6	Nichols Blvd.	$203.26	$3005.56	On 20 ft 2-Panel Hex. Dean
		Extra Concrete cu. yd.	8.4			84.00	Bond Ins. & Med. Aid @ $.04 per sq. yd
		Int. Curb lin. ft.	748.0			42.00	Forms .02" " "
		Secured Forms	909.0			84.00	Curing & Cleanup .04
						3418.82	

Pavement Crew	Hours	Rate	Total Amt.
Foreman	9	$1.25	$11.25
Mix. Operator	9	1.25	11.25
2 Finishers	18	1.25	22.50
2 " Helpers	18	.62½	11.25
2 Rodders	18	.75	13.50
3 Spreaders	27	.75	20.25
1 Rollerman	9	.75	6.75
1 Formsetter	9	.87½	7.88
3 laborers	27	.56¼	15.19
1 Utulity Man	9	.56¼	5.06
Mixer Opr. Exp.	9	.25	40.00
1 water Boy			2.25
Integral Curb			
1 Finisher	9	1.25	11.25
1 " Helper	11	.62½	6.88
1 Form Setter	9	.75	6.75
2 Laborers	20	.56¼	11.25
			203.26

MATERIAL USED

Crew										
Cement Bbls	571	$2.75	$1570.25							
Sand Cu. Yds.	165	2.70	445.50							
Gravel " "	305	2.70	823.50							
3"x6" Header	909	$25/M	36.25							
Expan. Jnt. Mtl.	1905	.06	114.30							
Water (flat rate)			15.76							
			3005.56							

Recap

2100.6 @ 2.20		4621.32
8.4	10.50	88.20
748.0	.45	336.60
909.0	.03	27.27
		5073.39
Less Cost plus 5% for Sup. Ovrhd and incidentals		3589.76
* Profit		1483.63

* Market discount on Bonds not deducted

E.R.D. Inspector

H.O.Root

A. Faber Chief Engineer

tional operation and a possible source of machine delay.

Records of Construction Progress.—Since a record of actual construction progress covering an extended period is probably the best illustration of the adaptability of this design, as shown in the foregoing, the Table I is exhibited, being a record of the operation of two 5-sack pavers covering a period of about four months. Inasmuch as these machines laid both 6 in. and 5 in. pavement, curbs and sometimes extra concrete, all concrete is reduced to the cu. yd. basis and stated as equivalent sq. yds.

ress of city street work considerably as compared with straight highway construction. This is illustrated in Table I and Fig. 1 where the unusual progress for the week ending September 4th was due to the fact that one machine for the entire week worked in an outlying district where the blocks averaged about 1000 ft. long; and few, if any, underground structures were encountered. Table II, which is a copy of the progress report, and cost analysis of the best day's progress during the season, is taken from that week in that locality.

Fig. 1 is simply a graphical record of the

Table III—Bids on Hexagonal Slab Pavement for 1925

City Improvement Districts	6" Pavement	Price Per Sq.Yd.	Amount	5" Pavement	Price Per Sq.Yd.	Amount	Contractor
1	88698	$2.35	$208440.30	39210	$2.05	$ 80380.50	Olympic Const.Co.
2	57759	2.20	127069.80	12712	2.00	25424.00	J.C.Compton
3	19535	2.20	42977.00	Nil	-		Olympic Const.Co.
4	55160	2.27	125213.20	Nil	-		do
5	28164	2.20	61960.80	9202	2.00	18404.00	"
6	9777	2.17	21216.09	Nil	-		Parker & Schram
8	4476	2.15	9623.46	Nil	-		Olympic Const.Co.
9	Nil	-		1641	1.80	2953.80	do
10	3102	2.05	6359.10	Nil	-		J.C.Compton & Co.
Private Job #1	4513	1.90	8574.70	Nil	-		do
" " #2	14718	2.09	30760.62	26000	1.93	50180.00	Longview Dredg.& Const.Co.
" " #3	432	1.90	820.80	Nil	-	-	Olympic Const.Co.
" " #4	652	2.20	1434.40	Nil	-	-	do
" " #5	617	2.20	1357.40	"	-	-	"
Total	287603		645807.61	88765		177342.30	
	Average $2.245 per sq.yd.			Average $1.998 per sq.yd.			

same seasonal progress, on which has also been indicated the outstanding causes of low weekly averages.

Table III is a record of successful bids during the season 1925. The yardages shown are those actually placed which are generally somewhat higher than bid quantities.

In connection with Tables II and III it should be noted that payment to the contractor for the City Improvement Districts 1 to 10 inclusive are in the form of Local Improvement District bonds and that any market discount that may apply to the sale of these bonds is included in the bid price.

It is regretted that the writer is not able to show representative bids on work under the standard design where material prices compare favorably with those quoted here. It is thought, however, that an interested reader can apply these statistics to existing local conditions and draw comparative conclusions.

New Jersey Municipalities to Aid Highway Study.—With approximately 20 municipalities in the northern part of New Jersey represented on five study committees, the managing committee of the proposed street and highway conference of the metropolitan section of Northern New Jersey decided at a meeting in Newark to inaugurate without further delay, the actual study work in connection with the problems of the conference.

$27,800,000 Highway at Boston

A final report to the Massachusetts legislature has been submitted by the special commission to investigate the intermediate thoroughfare, proposed to relieve traffic conditions in the downtown section of Boston. The report urges the construction of a "loop" highway from the Boston end of the Charles River Dam to the junction of Albany St. and Broadway, Boston. The estimated gross cost is $27,800,000, and the estimated net cost, after the deduction of betterments is $22,000,000. The length of the proposed thoroughfare including street extensions is 13,200 ft. The report recommends that the work be done by a special commission consisting of the three street commissioners and two appointed by the governor.

Kentucky To Study Its Pipe Culverts.—The Kentucky State Highway Department is about to undertake a survey of existing pipe culverts on the Kentucky highways in cooperation with the culvert investigation being carried on by the Highway Research Board of the National Research Council.

Junior Engineers Wanted.—The U. S. Civil Service Commission, Washington, D. C., has announced an open competitive examination for junior engineers in government service. The entrance salary is $1,860 per year.

Side Street Economics

How Classification and Improvement of Street According to Traffic Use Makes Possible Increased Paving Programs

By ALFRED S. MALCOLMSON
Civil Engineer, New York City

Nearly every city, village and small town in the United States is faced today with increasing demands for street improvement and that demand is one which is likely to grow continually and rapidly for many years to come. The situation in the smaller communities is frequently complicated because of the unwillingness of one section to wait its turn while another is improved. Any comprehensive construction project assumes such proportions that it is, or seems, prohibitive, and the result is that either nothing at all is accomplished or else some wholly inadequate makeshift is adopted.

A study of the economics of the situation will often reveal a solution which will either completely solve the problem or considerably alleviate the conditions. The usual planning of street improvements proceeds upon the tacit assumption that all streets are alike as regards the traffic they should be designed to carry, but nothing is farther from the truth. Needless and wasteful expenditure of large sums of money occurs almost daily because of failure to distinguish between highways and byways.

Highways and Byways.—Highways may be defined as thoroughfares or streets which are apt at any time to be subjected either to continuous traffic in considerable volume or to the frequent passage of heavy loads, and those on which such conditions already exist. Byways are those which are so located with reference to present or prospective traffic lanes that they will scarcely if ever experience a continuous volume of traffic and upon which the only heavy loads to be anticipated are an occasional moving van or coal or lumber truck.

Examples of the latter are to be found in nearly every locality and frequently more often in a large city than in a small growing village, while out in the country the percentage of byways is usually at a minimum. A dead-ended street is frequently but not necessarily always a byway, for it may lead to a dock or depot or to any point where a change occurs in the type of transportation or where goods are converted or produced. And it occasionally is so situated that future developments may open its end and make of it a thoroughfare. The test is whether it does now or may some day lead to any place in particular and if so what that place is. Its length may likewise enter into the determination, as also the nature of usage to which property facing upon it is put.

Such tests often disclose overwhelming byway characteristics in streets which are more than mere dead-ends. They may be of considerable length and have numerous intersecting streets and yet by reason of grade or zoning restrictions or other factors it may appear most certain that they will never be called upon to carry highway loads. This is often true of purely residence sections situated well without the range of possible or probable business encroachment, or backing up against some natural barrier such as a hill or stream. Frequently under such circumstances all but possibly one or two of the streets in an entire section may properly and safely be classed as byways.

Moreover there are many border-line cases where a street may be definitely in the byway class today but with a fair possibility of eventually becoming a highway. In such circumstances a proper quantification of the economic factors may show clearly in which class it should be placed at any given time. And finally there are cases where a street may have all of the elements of a highway and yet be placed definitely in the byway class by fiat or government decree, or even by mere warning of those who might be tempted to use it as a highway. It is a common occurrence in many localities today to find some streets on which only light traffic is permitted, and frequently highway bridges are posted for maximum safe loads. It would seem perfectly feasible and proper for municipalities to carry those precedents further where legitimate economics can thereby be effected.

Condition Survey Desirable.—Every community with a present or approaching program of street improvement will find it highly prof-

itable to make or have made a survey of conditions which will result in a classification segregating the highways from the byways. This will involve a careful study of some of the border line cases and perhaps some computations to determine in which class they should fall from an economic standpoint. Some may properly be placed in the byway class temporarily with full recognition of their probable future development into highways.

Coincident with the survey there should be developed two distinct specifications or types of specifications applicable respectively to the highways and the byways. The former will ordinarily follow standard practice but may properly allow a choice of material such as concrete, asphalt, brick or bituminous macadam. This permits of selections where special conditions justify it and of keener competition where no choice exists, without in any way sacrificing ability to withstand the traffic.

In establishing specifications for the byways there is room for the exercise of considerable ingenuity and judgment. Four major factors should be studied and be kept constantly in mind; namely, the width of pavement necessary, its depth and composition, maintenance costs, and the nature of subsoil and drainage conditions.

Street Width.—Custom, and in many instances statutory requirements regarding the dedication of streets to the public, have made 50 feet between property lines a widely adopted minimum width of street. This width is frequently divided up into a 10-ft. strip on each side between curb and property lines, leaving a clear roadway of 30 ft. In purely residence districts, and sometimes in others, this ordinarily results in an economic waste which can only be justified on the very doubtful grounds that some day all of the streets will become highways.

Prediction of future conditions is of course always beset with uncertainty, but even in the hamlet a careful and intelligent study will segregate those streets which stand a reasonable chance of eventually being called upon to carry highway traffic and those which will not. Community growth ordinarily follows quite definite trends and the factors governing it are becoming much better known. The economies resulting from such a survey, if competently executed, are vastly greater than its cost.

A 36-ft. roadway will accommodate four continuous lines of traffic with a substantial margin to spare, which is at least twice the economic requirements of a byway. A thoughtful householder, if he were asked to assume a direct assessment covering the fixed charges and maintenance expenses for "parking pavement" in front of his property, would quickly refuse. A moment's figuring would show him that his car could never occupy more than 5 or 10 percent of it and that such occupancy would seldom be needed for more than 5 percent of the time on the average. The inclusion of "parking pavement" costs in the general tax budget is about the equivalent of giving a street car passenger who rides one block a reservation of 20 percent of the seating capacity of the car, for its entire trip.

If parking pavement or parking privileges be eliminated, a paving width of 20 ft. for a byway is ample, for continuous traffic does not exist upon it. A recognition of this as an economic conclusion and adaptation of a construction program to it will result, where 30 ft. roadways are the rule, in a saving of 33 percent on byways.

Adaptation is simple where streets are being newly laid out, and incidentally brings with it a more complete utilization of land area. Where much grading is involved, as on side hill work, it effects also a direct saving in construction cost and may improve the landscaping.

The streets which are already laid out may be handled in either one of two ways. A central pavement may be laid with an earth shoulder on each side, or the curb lines may be drawn together, with or without a corresponding adjustment in property lines. Often the extent to which permanent curbs have already been constructed will be a deciding factor.

Custom is also largely responsible for the use of a depth and composition of pavement on byways which is wholly unwarranted. The real destroyer of pavement is recurrent pounding, for where resiliency exists in the materials of which it is composed the occasional passing of a heavy load does little if any injury to it. And even though some actual injury may occur now and then the cost of repairs is ordinarily more than offset by the difference in fixed charges. Wherever this is true an economic justification exists for a lighter construction provided the pavement is made heavy enough to prevent miring.

Pavements for Byways.—Various types of paving suitable for byways have been or can be developed. Three or four inches of crushed stone laid on a thoroughly rolled sub-grade and bound with tar or oil and screenings has been used very successfully, and it has the advantage

that in case developments eventually require a heavier surfacing most of the material can be incorporated in it. An important matter to watch is drainage, and in a climate subject to frost extra care should be taken to insure a watertight surface.

The adoption of such a type of surfacing will make an additional saving at least as great as that due to lesser width, or possibly a total of 50 percent of all streets combined. Thus it becomes apparent that proper consideration of the economic factors involved will make it possible in many instances to double the mileage of streets which can be improved for a stipulated sum, or halve the cost of a given mileage.

Test Tax Case to Recover State Contract Profit

A petition in the test case by which more than one hundred construction organizations are represented in an effort to secure a refund of federal taxes assessed against the returns from public works operations has been filed with the United States Court of Claims. The petition, presented by Col. Jennings C. Wise, Jan. 8, 1926, is filed in the case brought in the name of the Luten Bridge Co., Inc., with offices in Knoxville, Tenn., and York, Pa. Institution of the test case is the result of Associated General Contractors activity.

According to the Feb. 15 Members' News Letter of the A. G. C., the petition in the Luten case indicates the company in 1921 received a gross income of $178,358.52 under contracts with a state or political subdivisions of a state; $20,039.96 of this amount represented profit. No other profit or income was received by the claimant the petitioner states during the year 1921.

During 1922 the company is shown to have paid $4,878.38 in taxes to the Collector of Internal Revenue at Philadelphia. On June 25, 1925, the claimant filed a claim with the Collector for refund of these taxes that had been paid. Later the claim was rejected by the Commissioner of Internal Revenue.

The court action for recovery is based upon the claim that "the company, in performing the work, was acting as a means or instrument of a state or political subdivision of a state, operating through the duly authorized agents of said state or political subdivision of a state in the exercise of a proper governmental function of said state or political subdivision of a state, and that the compensation derived by the claimant from said work can not constitutionally be taxed by the Government of the United States."

1925 Proceedings of the American Society for Testing Material

Volume 25, (1925), or the annual proceedings of the American Society for Testing Materials is now available.

This volume is issued in two parts:

Part 1 (962 pp.) contains the annual reports of 35 of the standing committees of the society together with the discussion thereon at the annual meeting. They include reports of Committees on Ferrous Metals, Non-Ferrous Metals, Cement, Ceramics, Concrete, Gypsum, Lime, Preservative coatings, Petroleum Products, Road Materials, Coal and Coke Waterproofing Materials, Electrical Insulating Materials, Rubber Products, Textile Materials, Thermometers, Metallography, including a report on Metal Radiography and X-ray Crystallography, Methods of Testing and Nomenclature and Definitions; 83 tentative standards which have either been revised or are published for the first time; annual address of the President and the annual Report of the Executive Committee.

Part II (454 pp.) contains 26 technical papers with discussion. These contain valuable information on results of investigations by experts in the field of engineering materials including the fatigue of metals, the effect of temperature on the properties of metals and investigations on the corrosion of metals. Motion should also be made of the many papers on cement and concrete and on the stability or bituminous mixtures as well as on such subjects as bituminous materials, paint, gypsum, brick, textiles, etc.

Each part may be obtained from C. L. Warwich, Secretary-Treasurer of the society, 1315 Spruce St., Philadelphia, Pa., at the following prices: $6.00 in paper, $6.50 in cloth and $8.00 in half leather binding.

Bulletin on Concrete and Steel Bond

"Studies of Bond between Concrete and Steel," by Duff A. Abrams, has just been published as Bulletin 17 of the Structural Materials Research Laboratory, Lewis Institute, Chicago. The report is reprinted from the 1925 Proceedings of the American Society for Testing Materials.

Bond tests were made by applying a pull on one end of 1-in. plain round steel bars embedded axially in 8- by 8-in. concrete cylinders; parallel compression tests were made on 6- by 12-in. concrete cylinders. The concrete covered a wide range in quantity of mixing water, cement and size and grading of aggregate. Tests were made at ages of 7 days to 1 year. Seven hundred and thirty-five pull-out bond tests and 735 parallel compression tests were made.

Highway Location

General Principles and Problems in Middle West Discussed in Paper Presented January 12 at Convention of American Road Builders Association

By RALPH R. BENEDICT
Assistant Chief Highway Engineer of Illinois

The problem of highway location in the middle west is different than that so fully covered by Mr. Crosby in his paper* before this convention. We have a checker board system of roads with a multiplicity of right angle turns at section corners. However, some general principles outlined in his paper are applicable to all situations, and it is of interest to discuss in some detail, a few of the points on the subject.

Educating the Public.—The matter of highway location is one that has been led up to by the gradual education of the public due to the rapid increase of motor vehicles and mode of travel. Only ten short years ago if a highway engineer had suggested the relocation of a public highway across a man's field, cutting it in two parts, he would have been prosecuted as a dreamer and one who was bent on the destruction of private property rather than the building of roads. We have in Illinois a horrible example of such a location started approximately 8 years ago—the matter of rounding corners with a 100 ft. radius was thought to be a foolish waste of valuable farm property and met with a great deal of opposition from the local people. The construction of this road has since served as a very valuable example, not only to highway engineers but to people of other localities who were interested in having roads located around their individual farm or home.

Manner of Locating Highways and Securing Right of Way.—The early location and construction of highways is parallel to the early building of railroads in the United States. The railroads now are spending large sums of money to relocate in order to reduce grades and lengthen lines, so as to increase the speed of operation and reduce the cost of maintenance. This problem is an acute one for the highway departments of the older states where roads have been constructed for a number of years. The freedom of action in the location of state highways is greater I believe in the middle west and extreme western states than it is in some of the eastern states.

In the preparation of the first bond issue law for the construction of roads in Illinois, a very important step was made—in that the termini and intervening towns were described in the original bill and also were voted upon by the people of the state, thus making it impossible to juggle routes from one side of the state to the other with each change of political administration. Also, this law gives the highway authorities power to make such location between the towns mentioned in the bill as may become necessary in order to carry out the provisions of the act. The following is the exact wording of the law:

"That the general location of the routes upon and along which said proposed roads are to be constructed shall be substantially as described in this section, so as to connect with each other the different communities and the principal cities of the State; Provided, however, that said Department of Public Works and Buildings shall have the right to make such minor changes in the location of said routes as may become necessary in order to carry out the provisions of this Act; and provided, also, that said Department of Public Works and Buildings shall not improve hereunder any road or part thereof which lies within any incorporated city, town or village in which the building of State aid roads may be prohibited by the Act of this State entitled 'An act to revise the law in relation to roads and bridges,' approved June 27, 1913, and the amendments thereto."

At the beginning of the construction of a state program, the department attempted to acquire the right of way from the bond issue funds voted by the people, but it soon developed that some localities through which relocations were necessary were demanding excess prices for their land. The department therefore changed its policy and now requires that the local communities furnish the right of way needed. This policy has been very successful and in most cases has met with the hearty cooperation of township and county road officials. Our local authorities are able to procure such right of way at very much reduced prices.

Practice in Illinois.—It is the practice in Illinois to have a very complete reconnaissance survey made before the definite location of

*See Roads and Streets, March 3, 1926.

the routes is decided. The very best engineers in the department are engaged in this survey work. A complete reconnaissance is made—measuring by speedometer or pacing relocations, the distance to travel, number of bridges to build, the number of railroad grade crossings, amount of grading necessary and all engineering features involved. A report is then made by the engineer on the various routes surveyed giving definite recommendations as to first, second and third choice. After this a public hearing is held and all of the people interested in the route are given an opportunity to be heard as regards the service the different locations may give to the local community. Upon the conclusion of the hearing, and taking the engineer's report as a basis, a definite location is selected by the director of the department and the chief highway engineer. The location in connection with cities and villages is left to a detailed survey study. The engineer of design of the department then goes over the detailed survey report and makes such minor or major changes as may be necessary to secure the best possible alignment.

Relocation Makes Possible Saving in Cost and Travel.—I have mentioned the outstanding location of one road in Illinois that is everything a state road should not be, with its multiplicity of right angle turns and adverse distance between two major termini. The major part of this adverse distance is the result of legislation; but some of it may be charged to location. As compared with this location, we have a highway between Springfield and Joliet in which relocation was made for 71.3 miles in a distance of 153 miles. A saving was made of 30.63 miles of travel; 62 right angle turns, and 22 grade crossings were eliminated. The saving on this stretch of road in dollars and cents to the motorists of Illinois, who are paying for the roads, based on a conservative traffic count of 1,000 vehicles a day at a cost of 10 cents per mile to operate is $3,063 per day—over $1,000,000 every year; or $20,000,000 over the life of the original bonds. There are a large number of instances similar to this throughout our state system, but the saving in mileage is not as great as in this particular case. A few of such locations follow:

Comparison of State Bond Issue Route 4 and Old Road (Burlington Trail) Between Springfield and Joliet

1.	Length of old road	183.60 Miles	
	Length of Route 4	152.97 Miles	
	Saving in length	30.63 Miles	
2.	Mileage of Route 4 on relocation	71.28 Miles	
	Mileage of Route 4 on existing roads	81.69 Miles	
	Total	152.97 Miles	
3.	Right angle turns in old road	59	
	Right angle turns in Route 4	7	(6 in towns)
	Right angle turns eliminated	52	
4.	Railroad grade crossings on old road	30	
	Railroad grade crossings on Route 4	8	
	Railroad grade crossings eliminated	22	(2 by grade separations)

Note: Length of both roads is figured through all towns, from Springfield Post Office to Joliet Post Office. In computing right angle turns and grade crossings, no account is taken of those on either road inside of cities through which the State did not build.

Comparison of State Bond Issue Route 10 and Old Road (Burlington Trail) Between Jacksonville and Springfield

1.	Length of old road	39.41 Miles	
	Length of Route 10	36.00 Miles	
	Saving in length	3.41 Miles	
2.	Mileage of Route 10 on relocation	6.87 Miles	
	Mileage of Route 10 on existing roads	29.13 Miles	
	Total	36.00 Miles	
3.	Right angle turns in old road	20	
	Right angle turns in Route 10	9	
	Right angle turns eliminated	11	
4.	Railroad grade crossings on old road	7	
	Railroad grade crossings on Route 10	1	
	Railroad grade crossings eliminated	6	

Note: Length of both roads is figured through all towns, from Jacksonville Post Office to Springfield Post Office. In computing right angle turns and grade crossings, no account is taken of those on either road inside of cities through which the State did not build.

Comparison of State Bond Issue Route 31 and Old Road Between Quincy and Ripley

1.	Length of old road	53.30 Miles	
	Length of Route 31	50.14 Miles	
	Saving in length	3.16 Miles	
2.	Mileage of Route 31 on relocation	17.78 Miles	
	Mileage of Route 31 on existing roads	32.36 Miles	
	Total	50.14 Miles	
3.	Right angle turns in old road	21	
	Right angle turns in Route 31	8	
	Right angle turns eliminated	13	
4.	Railroad grade crossings on old road	8	
	Railroad grade crossings on Route 31	3	
	Railroad grade crossings eliminated	5	

Note: Length of both roads is figured through all towns from Quincy Post Office to Ripley Post Office. In computing right angle turns and grade crossings, no account is taken of those on either road inside of cities through which the State did not build.

Comparison of State Bond Issue Route 2 and Old Road Between Carbondale and Cairo

1.	Length of old road	59.92 Miles	
	Length of Route 2	55.36 Miles	
	Saving in length	4.56 Miles	
2.	Mileage of Route 2 on relocation	26.68 Miles	
	Mileage of Route 2 on existing roads	28.68 Miles	
	Total	55.36 Miles	
3.	Right angle turns in old road	14	
	Right angle turns in Route 2	0	
	Right angle turns eliminated	14	

4. Railroad grade crossings on old road	6
Railroad grade crossings on Route 2	2
Railroad grade crossings eliminated	4

Note: Length of both roads is figured through all towns from Carbondale Post Office to Cario Post Office. In computing right angle turns and grade crossings, no account is taken of those on either road inside of cities through which the State did not build.

The early method in vogue of locating a highway, namely to form a connecting link between two places with as little expense and labor as possible, has been fully outgrown in the minds of most highway engineers; and the matter of first cost is a secondary consideration to that of operation after the road is completed. It is surprising how little has been done by some of the states older in highway construction to eliminate features of distance and grades on those roads of early construction; but the question of salvage of the old road has been one difficult to overcome as an economic feature.

Even though half of the traffic on the highways of the United States is for pleasure purposes, as statistics compiled by the Bureau of Public Roads show, the matter of location is just as important to this class of traffic as it is to commercial traffic. Excepting in isolated cases where scenic attractions are paramount—such as the wonderful Columbia River highway, and the Rock River highway of Illinois—the uppermost thought in the mind of the locating engineer should be to obtain the shortest route with the easiest grades.

Highway Research.—Although highway research has been confined chiefly to a study of surfacing, the results obtained have been productive in reducing the cost of such surfacing and thereby releasing more money for the location and construction of additional roads.

We are very apt to be critical of expenditures for highway research, but when results as outstanding as those of the Bates Road tests are reviewed, it behooves every highway engineer to foster and father as large a research program as his State may be able to carry on. The net saving to the State of Illinois as a direct result of the Bates Road tests is $3,600 per mile in standard road construction. This saving has amounted to approximately nine million of dollars in roads actually built since this experiment was undertaken.

Safety Rather than Speed Essential.—It is possible for a highway engineer so to locate his roads as to contribute very largely to the safety of the traveling public in the elimination of serious curves, short sight distance and steep grades. I do not believe we should regard speed as one of prime importance in road location; but rather that we should regard safety as the outstanding feature or "fourth dimension" as referred to by Mr. Crosby. Following is one of the conclusions given in the report of the U. S. Bureau of Public Roads on a study of the California highway system:

"It is believed that on main roads more satisfactory results will follow a considerably bolder standard of location and under modern traffic conditions there is an increasing demand for improvement of alignment and fast travel between cities. To this end design of highways must product in general a road that can be traversed at the speed of 30 miles throughout without excessive operating cost due to change of speeds."

It is the tendency of the time to increase the limits of speed on rural highways. Some states are going even stronger than the above recommendation and are now advocating as high as 50 miles per hour on certain stretches.

Court Decisions in Favor of Highway Location.—Recently, highway location has been drawn into the courts in the middle west. Some very important decisions have been handed down, upholding the highway engineers and officials; and against petty remonstrators. The latest decision of this nature is that given by the supreme court of the state of Missouri upholding the highway department in its location of an important cross state route so that it missed a certain village which would have taken through travel miles out of the way. At the present time Illinois has two cases awaiting the decision of the supreme court—one an appeal from a decision against the department, and one an appeal from a decision in favor of the department. Both of these cases are matters of relocation in connection with the state highway system.

Conclusion.—It has been contended by Mr. Crosby in his excellent paper that mass production tends to interfere with the proper study of highway problems. I would take very serious issue with Mr. Crosby on this point, as it has been our experience in Illinois that mass production is an incentive to better location, in that the locality benefited by the relocation or change in alignment will cooperate with the department and help to furnish the needed right of way with all possible dispatch. They realize that if this is not done, the roads in other localities will be built while they are awaiting the procuring of the necessary right of way. The question of the time needed for the study of location problems is only a matter of having sufficient engineers to make the preliminary surveys in advance of such a mass production program.

The mass production of Illinois has enabled it to break all highway construction records in the past three or four years.

Gang vs Caretaker Highway Maintenance

Past and Present Practices in New York State Reviewed in Paper Presented Jan. 14 at 23rd Annual Convention of American Road Builders Association

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The first definite highway activities in New York State were carried on in 1898 under the Higbee-Armstrong Act, which provided that highways were to be constructed under the direction and supervision of the state engineer and that the highways were to be maintained by the counties and towns. It, however, did not compel the counties and towns to raise money for this work and as a result these roads deteriorated very rapidly due to lack of care. This act definitely provided that the organization which carried on the construction of highways had no financial responsibility for maintenance of them.

Beginning of Highway Work in New York.—The first improved highway was constructed under this act in 1898, for which the legislature appropriated $8,000. The appropriation for highway activities in 1925 was $35,000,000, which indicates the demands that are being made on the highway engineer and the present-day requirements of expenditures in order to properly take care of the traffic which the highway are called upon to carry.

By 1905 the demands for roads had been so great that it was determined that the only way to meet the requirements was by a bond issue. On account of the lack of maintenance of the roads by the local authorities and their condition at that time, there was considerable opposition to the first bond issue. For the reason that no provision had been made for maintenance. The neglect of the highways during the first years was the controlling factor towards the formation of a highway commission in 1909, which divested the state engineer's department of any functions in highway matters.

First Maintenance Bureau Established in 1909.—With the formation of the highway commission in 1909 the first maintenance bureau was established as a separate and distinct unit in the department. This was a very crude organization and had considerable political color, as the chiefs of the sections were political appointments and were selected not so much for their ability as for their political standing with the party in power.

This organization was in operation until 1913 when as the result of popular clamor, there was a reorganization in the highway department and this work was placed under the direction and supervision of the division engineers, where it properly belonged. It meant that qualified engineers, trained in highway work, superseded the political appointee and that construction engineers in the different sections of their subdivisions were placed in direct charge of the work in their district.

In 1909, with the organization of the first maintenance bureau $1,500,000 were appropriated; in 1925 the appropriation was $15,000,000 for this work. In 1909 there were 2075 miles of highways, most of which were of the water-bound type; in 1925 there were 11,000 miles of complete highways in the system. During that interim great progress had been made in highway design and the hard-surface roads predominate.

The state is divided into divisions as headquarters and the divisions are subdivided into area organizations, which report direct to the division office. The divisions report to the commissioner of highways through the deputy commissioner in charge of the maintenance bureau.

Division Engineer in Charge of Maintenance.—The real keystone of the organization, the man behind the gun, who secures the results, is the engineer in charge of the district, under whom the field forces function. These engineers have direct supervision over the maintenance organization and also have charge of construction. Their experience in maintenance has resulted in a better design of highways, as they are not only familiar with the construction and design of a highway, but are forced to observe the failures, and naturally their instinct is to develop a design which will overcome the obstacles which brought about the failures. The advantage of engineers, who are in direct charge of construction, having

charge also of the maintenance, is a factor which makes for more permanent roads. They are naturally familiar with their district, with its requirements as to traffic and the probable increase in traffic; with the availability of material; and their natural tendency is to design and construct a road which will require the least amount of maintenance. As this man's judgment must govern highway matters in his district, careful selection must be made of the type of engineer to hold this responsible position, as he is the direct liaison officer in all highway affairs.

Political Patrolmen.—The provision made for our early organization in the maintenance and repair of roads was a man with a horse and cart who had a patrol of about three or four miles. This man was a political appointee, designated by the local authorities as a reward for his political ability in securing votes. This type of man did not produce the required results and made it difficult for his immediate superiors. After the department was reorganized the name of "patrolman" (which is used in this paper as synonymous with "caretaker") was a misnomer. When a patrolman was directed by the engineer in charge of the district to repair the highways he often questioned the authority, as their idea was to patrol their districts in a policing sense more than a working sense.

Today we have a system of maintenance foremen and light maintenance foremen, who are civil service employees, having been appointed after a competitive examination. This method has supplied us with an organization of 100 per cent qualified men, men who were appointed because of their ability to do the work and not on account of their political activities.

The credit for this is due to the present Superintendent of Public Works, Frederick Stuart Greene, who "put it over" with the concurrence of Governor Smith and the cooperation of Commissioner Arthur W. Brandt. These men realized that this step was of the greatest importance to the efficient operation of the maintenance bureau of the highway department. This makes a straight line organization from the division engineer down, and with the highly-trained organization thus affected, is in a position to efficiently handle its constantly increasing and widening field of work. It is now a well-trained business organization as well as a highly trained technical body and is enabled to handle its work to the best advantage and interest of the taxpayers of the State.

How Early Maintenance Was Done.—The first repairs to holes in pavements (the roads were then all waterbound macadam) were made by simply filling in the depressions with screenings or No. 1 stone and trusting to the grinding action of the then wagon wheel traffic and rain to make a permanent patch. Soon asphalt and tar binders came into use and these were heated in small portable kettles which could be pulled by a single horse. The advent of the asphalt and tar binders meant a great advance in the methods and results obtained in the repair of pavements. At this time the crushed stone and other materials used for repairs was hauled from its source of supply locally or from the railroad station after being unloaded by manual labor in wagons, more often than not, of the old slat variety, by which considerable time was lost in unloading, etc.

Shoulder and ditch work was done by manual labor or by teams dragging a road machine, and the patrolman was given an extra helper or two for the season. The grass was cut by farmers living along the line. The guard rail was painted either by contract or by a regular painter with lead and oil. This was an expensive proceeding as well as slow and resulted in some guard rail not being painted at all and some not until too late in the season to be of much help to the traveling public in showing dangerous places, especially at night.

Modern Methods.—With the advent of the motor truck a floating gang, with a foreman, rented truck, and eight or more laborers, was put on in the county to assist the patrolman, take care of the heavier work and unload materials. Increasing motor traffic, especially of trucks, made more and more heavy repairs necessary and more heavy trucks and gangs were used.

Soon the horse and cart began to disappear. A light truck with a working driver, or patrolman, and three helpers, began to absorb the work of several horse and cart outfits, taking care of 18 to 24 miles of highway. In a short time the horse and cart became absolute except in isolated regions, and the light truck patrol, assisted by the heavier gangs, became established.

Methods of unloading stone were simplified by portable unloaders or conveyors, putting same on motor trucks, which were able to make long and hilly hauls, impracticable for teams.

Surface treatments were now made by department forces, the stone being unloaded by the larger trucks and assisted by the light trucks in distributing in small piles ready for spreading after the bituminous materials had been spread by motor truck tanks. Improvement in size, portability and efficiency of asphalt heaters made for better work, as well as expediting the completion of the same in the spring. The advantage of having surface

treatment done by the regular maintenance organization is that we have been able to complete all the surface treatment by the 1st of June. The advent of cold patch material made an expedient method of filling up small depression by the light gangs in the early spring or when the larger heaters were busy with the big gangs elsewhere.

With the increasing mileage of concrete roads and the constantly mounting traffic, the work of maintenance began to shift more toward shoulders, widening of curves and actual widening of the pavements and highways. The quick-setting cements make it possible to replace sections of a broken concrete pavement within a few hours.

Increased Use of Machinery.—More and more machinery came into use in all branches of maintenance. Truck cranes for unloading material, steam shovels, steam and gas rollers, mixers and motor mowing machines came into being, as well as many special smaller tools. With the coming of all this machinery it became necessary to provide storage for the same, some of it in the counties and some in a division storehouse where repairs could be made in winter and from which service could be had during the working season for the heavy trucks, etc., which were now all state-owned and necessarily must be kept in running order. From a crude affair this has developed into a highly-efficient machine and repair shop, with storage and stockroom and equipment, as well as a trained personnel necessary to its numerous and various classes of work. This storehouse, etc., is under the supervision of the engineer in general charge of maintenance for the division, under the division engineer.

Traffic signs.—With the constantly increasing auto traffic, native and foreign states, it became necessary to mark main routes, put up danger and curve signs and other means of aiding travelers. These signs are put up by the light truck gangs and the painting and lettering is done by carefully selected men. Guard rail is now painted yearly by the patrol organization, using cold water paint. In this way the total amount of guard rail is painted a bright white, lasting for the season, in a short time, thus making the guiding effect of the white rail available for practically the entire traveling season.

It is thus the present system of maintenance has evolved from the original crude and old-fashioned method. The old horse and cart with a three or four mile patrol, dependent upon local teams and labor for help in all but the most simple tasks has given way to the light patrol truck outfit with the general care of 20 miles of highway with the help, in heavier work and of unloading and hauling materials, etc., of the heavy trucks and their large gangs.

With the aid of the modern highway machinery and additional trucks, considerable work done by contract is now done by department forces. In fact the organization and equipment is so complete that within reasonable distance of the service of the repair shop and where local labor is available near the larger cities, work of resurfacing, reconstruction and actual construction of highways is being accomplished.

Advantages of Flexible Organization. — There is another advantage in this flexible maintenance organization and that is we have been able to carry on heavy construction work, which comes under the head of research and demonstration work, which supplies the department with fairly accurate cost data and with aboslute certainty as to methods of work and what can be required in the specifications. It also brings out phases of where our specifications are not practical. This method of carrying on maintenance has developed an organization that is capable of coping with any conditions which the elements create, like floods and washouts, where structures are demolished or fail.

The subject of this discussion is Gang versus Caretaker Maintenance. As I take it, Caretaker Maintenance means local patrolmen on definite beats; gangs are roustabouts, capable of taking care of any situation. My reactions and conclusions are that all patrol organizations must be augmented by gangs to work efficiently and secure results, for the reason that many times the work is too heavy for a small crew and it drags, which inconveniences the traveling public. This heavy maintenance crew is always capable of handling and manning all kinds of machinery and equipment.

Whatever the present results of maintenance may be, an efficient organization is constantly searching for betterment, both from an economical standpoint and the physical results that are obtained.

Whatever type of maintenance organization is developed in a state, county or district, a definite program must be laid out and it must be followed by a positive attitude if there is any desire for success or for complying with the requirements of the traffic which is encountered today.

The slogan of all highway departments should be that "Every public expenditure must be a public investment."

Patching and Resurfacing City Pavement

Methods Employed at Richmond, Ind., Described in Paper Presented Jan. 22 at Twelfth Annual Road School, at Purdue University

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City pavements are structures which, are subjected to very great abuse. Consequently they must receive considerable attention and repairs to keep them in a serviceable condition. The causes which contribute most largely to their deterioration can be defined as those due to foundation defects, surface defects, presence of street car tracks therein and utility cuts.

Utility Cuts.—The cuts in pavements made by utility companies, cause greater distress and inconvenience to the official and the traveling public than any other. Although efforts are made to get a sufficient number of service pipes laid prior to laying of the pavement, the growth of cities and business constantly necessitate the laying of additional mains and service connections. This is a temporary inconvenience and should not be discouraged, but rather it should be so regulated that repairs can be made quickly and efficiently.

For the city to properly maintain its pavements, it is necessary that complete control be had over all excavations and replacements. If complete responsibility is centered on the city authorities, they may then receive the censure for negligence or likewise may receive the credit for strict attention.

In Richmond, Ind., such responsibility is placed upon the city by ordinance. The city refilling all trenches and replacing the surface with its own forces.

In this connection, it is essential to good business that costs be kept of all repair work. This may be done effectively by means of the usual work-order system. In this way relative costs can be obtained for repairing cuts in the various types of pavements.

Equipment for Patching.—For the efficient repair of pavements it requires adequate equipment and tools. Considerable saving may be effected by using modern methods and modern equipment.

For patching, the Richmond street department has an outfit consisting of a Fordson Tractor pulling a two wheel trailer wagon, having a capacity of 2½ cu. yds. This wagon was constructed in the city work shop. The body is of wood, resting upon a low wheel trailer support. The sides of the bed are hinged at the third point, to better facilitate the removal of material when the bed is partially empty. Attached behind the trailer is a tar heating kettle. It has a warming rack under the hood for an extra barrel of tar. Two men, the driver and a helper, constitute the working force for each patching outfit.

Methods of Repairing Service Cuts.—When an excavation has been made in any pavement and the trench ready for refilling, the city is notified by the party making the service cut. The filling is then replaced in layers and thoroughly tamped. If saturated clay or other soft material is at hand, it is replaced by gravel. This is essential if a firm sub-base is to be secured in any reasonable length of time.

In gravel and macadam pavements, after the earth is replaced, the old surfacing material is used on top, care being used to leave it level with the surface of the surrounding pavement and not heaping it up to allow for future settlement. The trench will no doubt settle somewhat, in which case it should be refilled until it is ready for the placement of the permanent surface patch. To leave a trench heaped high, without adequate red lights, is negligence in this motor age.

In the case of trenches in the business district, where there exist plate glass show windows, no temporary surfacing material should be used which contains particles which can be thrown through the glass by passing autos. We have found that a layer of rock asphalt is most effective for this surfacing. Its cohesive character tends to prevent the dislodgement of any loose particles and gives a smooth riding surface while the trench is adjusting itself for its permanent patch.

In placing the permanent patch on trenches in a surface treated gravel or macadam pavement, certain requirements should be met. The top material should be removed to the required thickness of 3 in. If there is a lack of sufficient foundation material beneath this thickness, it is provided in the usual way. For the permanent patch, coarse stone is thoroughly tamped into the trench over which 1½ gal. per sq. yd. of Tarvia X is uniformly poured. Over this is

then spread a sufficient amount of ¾ in. stone chips to completely fill the voids and leave a slight excess. When these chips are tamped into the coarse stone, ½ gal. per sq. yd. of Tarvia X is again uniformly poured over the stone and especially along the edges of the patch. Over this second pouring, a light layer of coarse sand is spread. Particular care is used to keep the patch level with or slightly below the surrounding pavement.

In patching small depressions in surface treated gravel or macadam streets, a somewhat different method is followed. After the depression is thoroughly swept free of all dust and foreign substance, by a steel or stiff fibre broom, a light coat of Tarvia X is sprinkled around the edges of the patch and clean ¾ in. stone chips are spread, leveled and tamped smooth. A light weight, straight edge is useful in testing the finished tamping to determine if it is above the surrounding surface before the tar is poured over it. For a finish, a light sprinkling of sand is applied.

Gravel or macadam pavements which have not been surface treated should not be patched with bituminous materials. As these bituminous patches will after a short while stand up like islands in the street, due to the surrounding pavement wearing faster than the patch.

Patching Pavements.—Rock asphalt is a material, which we have found, lends itself readily to patching various types of pavements. This material has the advantage of being easily stored for future or constant use, without losing any of its inherent qualities or without the need of mixing other materials with it. We have used it for patching both concrete, sheet asphalt and brick pavements.

Depressions in concrete or brick are first swept clean, the surface painted with asphaltic cement and the rock asphalt tamped or rolled into them. The level of the rock asphalt should be left at least $\frac{1}{8}$ in. high to provide for the compression which traffic will ultimately give it.

To patch sheet asphalt, the old surface material is cut out completely as in repairing with sheet asphalt. The sides of the patch are made rectangular in shape with the thickness of the old surface cut vertical. After cleaning out all foreign matter, the edges of the old pavement are painted with liquid asphalt and the rock asphalt spread and compacted as for repairing concrete or brick.

To secure a smooth job, it is essential that the rock asphalt be pulverized into as small particles as is possible by means of raking and no lumps should be left on the surface. In cool weather this pulverizing can be materially expedited by warming the material before spreading. Our heater, which was designed by the street commissioner, is a double sheet iron pan with sides, mounted on low iron wheels, with a stack at one end. A small fire is maintained under the heating surface, upon which is deposited the lumpy rock asphalt. An attendant keeps the material stirred with a rake until the lumps are all broken when it is wheeled or shoveled into place in the patch. The warmed material resembles sheet asphalt surface mix, crawling and full of life. Constant stirring will prevent burning while warming.

Cuts made in brick pavements are replaced with brick. A substantial foundation composed of 8 in. of portland cement concrete reinforced with wire mesh or rods is laid 3 in. wider than the trench. This is to furnish support for the slab. Upon this is placed the sand bed and the brick in the usual manner. The joints being filled with asphalt or tar.

Cuts made in concrete pavements are likewise replaced with concrete. Formerly this was considered impossible, but now is done very successfully if but a few details are observed. The edges of the old concrete are thoroughly cleaned with water, using a wire brush. This cleaning should not be slighted in any respect. A thin paste of rich mortar is then brushed over the cleansed surface with an old broom. Before the surface of the edges has dried, the concrete for the bulk of the patch is poured, tamped and finished as for concrete pavements. The important item is to travel the edge of the patch, where it meets the old pavement, in such a way that there will be little chance of raveling. The patch should be cured to prevent rapid, excessive shrinkage. The use of quick hardening cement is fast coming into use for street repairs and is especially suited for patchwork such as this.

Cracks in concrete pavements should be repaired immediately after they become of such width that liquid asphalt or tar can be poured into them. When cracks in concrete pavements are not properly filled, traffic soon ravels out the edges until they become unsightly. Concrete pavements should be thoroughly inspected in the fall of the year and the repair work finished before cold weather.

Fundamentals in Patching Pavements.—Our experience in patching pavements has taught us the following fundamentals which we endeavor to have the workmen follow:

Bituminous patches on unsurfaced treated gravel or macadam have proven unsatisfactory.

It is better practice to replace pavements over service cuts, using the same type materials as the original pavement.

In pouring a bituminous patch, to use sufficient material to coat the particles without making it "fat."

Paint-coat the surface of old concrete or brick where rock asphalt is used as a resurfacing.

Observe the little details of construction which have been evolved from the experience and experiments of others. Do not treat them as being inconsequential or unnecessary. They are the result of the failure and success of others before you. Profit by their mistakes.

Resurfacing City Pavements.—Most modern city pavements consist of a foundation and a surface course; either constructed separately as with sheet asphalt or brick on a rigid or flexible base or constructed simultaneously as a concrete pavement.

For any type of pavement to give continued service it is essential that there exist a well drained sub-soil, a stable foundation and a wear resisting surface. In years past many such wonderful pavements of various types and designs were constructed, returning to the taxpayers every dollar's worth of investment in real service. But as time progresses and traffic increases, the surface of these pavements wear down, some evenly and some so unevenly that they become unfit for travel. Whence, complying with a popular demand for a new, smooth pavement, the authorities proceed to replace them. In many of these cases, all that is needed is a renewal of the surface course. The foundation may be in perfect condition, having received the compaction of years of traffic, which is so much more effective than can be secured in any other way.

Inasmuch as economy is the aim of good engineering, it behooves the one in charge to make all necessary investigations to determine the adequacy of the existing foundation, to the end that it might be preserved. If such can be accomplished, a saving of approximately $1.20 per sq. yd. will be made.

When all information is at hand, the design of the surface for each particular job can then be determined on its merits and becomes purely a matter of the engineer's judgment.

In Richmond, we have effected a considerable saving, by using a bituminous surface over old worn pavements. This resurface work has come under two heads; that which is done without removing the old pavement surface and that which does remove it.

In our experience we have resurfaced with the following types: Bituminous macadam over old gravel and old macadam pavements. Sheet asphalt over old gravel and old macadam pavements. Rock asphalt over old macadam and old brick pavements.

Preparation of the Surface.—Where a bituminous top is to be laid over an old gravel or macadam street from which a portion of the old surfacing is to be removed, great care is exercised in making the excavation. The scarifier teeth are adjusted that only part of the required depth is loosened at a time leaving the surface firm and compact after the removal of the loosened material.

Where the depth of the gutter may be reduced, the present surface is first cleaned, and when using sheet or rock asphalt for the surfacing, the pavement is brought to profile by the use of black base. When using bituminous macadam for the surfacing, the small irregularities can be adjusted by an excess of stone.

Soft places in the foundation and service cuts are reinforced by a 6 in. portland cement concrete or black base slab.

Rock asphalt is a material which is well adapted for resurface work. It has been used successfully in many cities in this state and others. It is a material comparatively simple to handle and requires a minimum of contractor's equipment.

In the resurfacing of old macadam, it is essential that the rough aggregate in the old surface be exposed by thorough sweeping. This provides a bond for the surfacing asphalt. If a firm, clean surface cannot be obtained, it is often advisable to excavate and replace with a layer of new stone 2½ in. in thickness, constructed and water-bound as in macadam base construction.

Guide strips are laid 4 to 5 ft. apart between which the asphalt is raked and smoothed. The strips are of such depth as to provide for ⅓ compaction.

Care is exercised in thoroughly raking the material and leaving the top of the finished surface free of all lumps. Rolling is done in the customary way with a ten ton roller, until the surface is smooth and compact.

In resurfacing over brick or concrete the surface is thoroughly washed and swept clean, then brought to profile with black base after which the cleansed surface is uniformly painted with asphaltic cement by means of an ordinary whitewash spray.

If desired, the rock asphalt may be feather edged 5 to 6 ft. from the gutter and also at the car tracks, if any exist.

One inch thickness has proven suitable for this surfacing.

Sheet asphalt has been and is now being used quite extensively as a resurfacing over old pavements of all types.

This material is laid in resurface work similar to constructing it on a prepared foundation. Sheet asphalt cannot be successfully feather edged. It requires a shoulder.

How to Secure Greater Output in Concrete Road Construction

Results of a Study of Concrete Road Jobs by the U. S. Bureau of Public Roads Given in a Paper* Presented Feb. 24 at 22nd Annual Convention of the American Concrete Institute

By J. L. HARRISON
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The Bureau of Public Roads determined to subject a considerable number of concrete construction jobs to a detailed analysis for the purpose of ascertaining what causes prevented consistent production at the rate theoretically possible and whether these causes were avoidable. The analysis of this matter has covered three distinct phases: first, What is full production? second, What causes interfere with it, and how much do they interfere? and third, Are they avoidable? To answer the first and second of these questions, the operation of a considerable number of mixers at work in the field was subjected to stopwatch analysis. Men were sent into the field and kept on a project for from a few days to a couple of months collecting readings on all phases of the work. When the data seemed to show that an operation could be performed within a certain time, though it might not have been performed consistently within that time on the jobs studied, an effort was made to locate a job where it was so performed and there to study conditions with particular care. Finally as a means of determining that the causes interfering with production are avoidable, a number of jobs were found where the contractor offered to co-operate in an effort to demonstrate that prevailing causes of underproduction are avoidable by making such changes in construction practices as the stopwatch studies showed to be necessary in order to secure full production.

The Mixer Cycle.—The studies which were made to determine what is full production began with a study of the mixer cycle. These studies at once showed that from 9 to 10 seconds are required to raise the skip. Of this time, the skip is discharging into the drum during from about 1½ to 2 seconds. After the skip is in vertical position, some time is required before all of the material which it contained is emptied into the drum. Different types of mixers differ a good deal in the time required here. The nature of the materials also affects the discharge time. The faster mixers generally take from a little under 4 seconds to a little over 5 seconds. An allowance of 5 seconds for the lag in discharging the skip is appropriate for such mixers. The time required in mixing a batch (over the larger part of the region where these studies were conducted) is 60 seconds after all materials are in the drum. After the bell on the timer rings it takes a little time to set the levers and for the discharge mechanism to work. This generally amounts to about 2 seconds. It may amount to more but when it does it is apt not to be uniform. Time so used extends the time of mixing correspondingly. The discharge requires about 10 seconds if a mix of proper consistency is being had. Sloppy concrete discharges faster because it does not pile up in the bucket or in the chute. Discharging the drum should, of course, overlap raising the skip. There results, then, the following mixer cycle:

Raising the skip with simultaneous discharge of batch		10 sec.
Lag in charge	5 sec.	
Mixing time	60 sec.	
Total	65 sec.	
Less lag in discharge	2 sec.	
Set Timer	63 sec.	63 sec.
Lag in discharge		2 sec.
Total mixing cycle		75 sec.

This is 48 batches an hour.

If, now, raising the skip is delayed until the drum is emptied, the cycle is extended to 85 seconds and the possible production per hour is reduced to a fraction over 42 batches—a reduction of between 12 per cent and 13 per cent. Again, if, as an illustration, the operator still further delays matters by not only emptying the drum but also running out and emptying the bucket before he starts the skip the mixing cycle is extended to about 90 seconds and output is reduced to 40 batches an hour, a loss of output amounting to about 17 per cent. It may be interesting to note that as a matter of observation and record, very few jobs have been found on which the operation of the

*"Efficiency in the Supervision of the Construction of Concrete Road Surfacing." Printed here is an abstract of a preprint from the 1926 Copyrighted Proceedings American Concrete Institute.

mixer is so well handled that the 75-second cycle is attained with even fair consistency. The Bureau's representatives found one such job this summer. Full attainment of this cycle is hard to obtain but an average cycle within about a second of the ideal is not difficult to obtain with a good mixer as has been fully demonstrated by the Bureau's engineers who have found a substantial improvement of the mixer cycle generally the easiest part of any effort toward "speeding up" a job.

Mixer Drum Speeds.—The correct mixer cycle involves one or two matters about which there may be some question. In the first place, if raising the skip and discharging the drum are overlapped, charging the drum and discharging it will occur simultaneously during the last 2 seconds of the period required for these operations. As the standard drum speed is about 15 revolutions a minute—one revolution every 4 seconds—such material as runs

Table I—Stopwatch Studies on Concrete Road Construction (Study No. 58-B)

Date, June 30, 1925
No. Batches Placed, 31 Time, 1 hour

Mixer Cycle, time in seconds.			Time (in seconds) Lost by Mixer Due to the Following Causes.			
Charge.	Mix.	Discharge.	Mixer Delay Due to Operator.	Insufficient Truck Supply.	Trucks Delayed Because of Mechanical Trouble.	Delays Due to Miscellaneous Causes.
10	50	10	5			
9	50	10	20			
9	50	10	5			
10	50	10	10			
9	50	10		90		
9	50	10	2			
10	50	10		25		
10	50	10		66		
9	50	10		57		
10	50	10	5			
10	50	10		9		
10	50	10		101		
9	50	10	7			
10	50	10	10			
10	50	10	5			
9	50	10		77	17	
10	50	10			22	
9	50	10	22			
9	50	10	16			
9	50	10	10			
10	50	10				
10	50	10	42			
9	50	10	35			
10	50	10	5			
9	50	10	16			
9	50	10	9			
10	50	10		57		
9	50	10		21		
10	50	10	20			
10	50	10	40			
10	50	10				215
Averages.....	50	10	10.2	10.2	0.1	10.2
Percentage of Working Time.	50½	8½	9	11	1	9

into the drum during this period cannot, of course, be raised high enough and moved over far enough to appear in the discharge. If any does not appear it is an indication of too high a drum speed and the contractor should correct the condition by reducing the drum speed to normal, for, under current specifications, he obtains no advantage whatever from operating at a high drum speed. Just why specifications are written in this way the writer has never been able to learn. Specifications commonly permit speeds of from 14 to 21 revolutions a minute. Mathematical analysis suggests that at the higher of these speeds the action of the materials in the drum can hardly be sufficiently different from what it is at 14 revolutions to justify any other conclusion than that at 21 revolutions it receives approximately 50 per cent more mixing than at 14 revolutions, these remarks applying to a 6-ft. drum. If, on the other hand, the rate of revolution is increased much beyond this point, mathematical calculation indicates that the centrifugal force is likely to play an important part in reducing the mixing effect. The natural deduction from this is that while, under current specifications—a one-minute mix at about 15 revolutions per minute—the 75-second cycle is not likely to be much reduced by any change in mixer designs, it may be practical to reduce it to about 60 seconds by increasing the mixer speed to about 20 revolutions per minute. If it should be found by test that this gives the same amount of mixing which concrete is now receiving, no important change in the general design would be required while, of course, possible production would be increased to 60 batches an hour, which is about as high a rate of output as, on the basis of data now in hand, it seems possible to attain under field conditions because of the numerous correlated operations that it would be difficult to hold constantly within any shorter time limit.

The second point relative to the 75-second mixer cycle is that, as mixers are now designed, the discharge must be forced to keep it within the 10-second limit on which this cycle is based. The bucket on most mixers is too small to properly accommodate a dry batch. Most mixers also dribble the discharge a little. Some dribble it a good deal. This is a matter governed by the design of the blades and the shape of the drum. Obviously, with all the batch in the mixer, the blades work through a "pool" of concrete lying at the bottom of the drum. As the discharge proceeds the depth of this pool decreases. If, then, the blade construction is such that more or less of the concrete which is raised for discharge falls clear of the discharge chute, the process can continue almost indefinitely. With most mixers, the dribble can be avoided by reducing the discharge time to 10 seconds which, during the discharge of the first few batches, will result in leaving a little concrete in the drum. Within a short time, the amount thus accumulated in the drum will be sufficient to force the discharge of a full batch during the 10-second discharge period. The amount thus left in the drum is not large and as it is, with full production, combined with a new batch every 1¼ minutes, no bad results can reasonably be ascribed to the practice.

Synchronization of Related Activities.—One of the requirements in efficient superintendence is synchronization of all related activities. This, for such a manufacturing process as laying concrete pavement, suggests two things:

first, that the mechanical unit which turns out the product (in this case the mixer) shall, if possible, be the pace-maker for the work, and, second, that the rate of production in all related or subordinate operations shall be governed by the pace-maker.

On a concrete paving job there are a number of operations definitely subordinate to the mixing operation. Materials must be loaded onto the transportation units. These are sand, coarse aggregate and cement. These transportation units, if they are trucks, must be turned around at the site of the work, backed to the mixer and their contents dumped into the skip. If, then, any one of these operations takes longer than is required to mix a batch of concrete, this becomes the pace-maker for the job. Thus, in the case of a poorly designed gravel loading bin, it sometimes happens that the time taken to load a truck is greater than the time taken to mix the batch. One such installation was found this summer where the time required in loading a single batch of aggregate at times averaged three minutes. The capacity of the mixer is of no consequence while such equipment is in use for it very effectively controls the rate of output. In this case, production was, of course, cut to less than 20 batches an hour and it is needless to remark that if such a device had cost nothing at all and had required no labor in its operation it still would have been an expensive installation for the extra time taken by the trucks in obtaining a load, not to mention the low efficiency at which the crew about the mixer had to work, were items of expense that far outweighed any saving obtainable from the material handling equipment.

Handling Cement.—Handling cement is more often the pace-maker on the job. This is outstandingly the crudest operation on most concrete paving jobs. It is, today, almost exclusively a manual operation. Generally some five or six men are employed in handling cement—about twice the number required for handling some five or six times the weight of coarse aggregate. The ordinary practice is either to throw the proper number of bags of cement into the trucks on top of the aggregate at the cement house, putting a man onto the truck at the mixer to empty them just before the batch is dumped or to send the cement to the work in separate trucks, placing it in piles along the road to be later emptied into the skip. In either event, the operation is apt to conflict with fast production. If the cement is sent out with the aggregate on single batch trucks, one man is all that can work effectively in unloading it. Sometimes one cuts the wire fasteners and another follows emptying the sacks. But emptying the cement is heavy work and if it is not carefully supervised the material supply will be held up a few seconds here and a few there to the material detriment of the day's run.

If the practice of sending out the cement in separate trucks and piling it along the road is followed, delays are still more frequent. The mixer cycle is 75 seconds. Of this time at least 17 seconds—10 to raise the skip, 5 to fully discharge it and 2 to drop it—are needed in handling the skip. More often 20 are taken by the mixer operator. Commonly, dumping the aggregate will take at least 15 seconds. There remain, then, with everything running smoothly and on schedule, not much more than 40 seconds in which to empty five sacks of cement. This is enough if two strong men are employed, but whenever there is any delay in the arrival of a truck, as inspectors commonly refuse to permit the cement to be dumped before the aggregate is dumped, dumping the cement causes an extension of the mixing cycle.

An appropriate remedy for this situation is the installation of some sort of practical mechanical means for elevating the cement

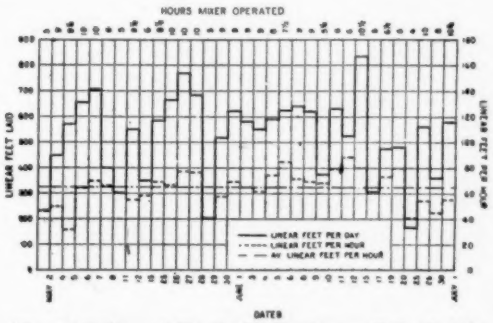


Fig. 1—Daily and Hourly Production on Federal Aid Project

at the cement house to a point from which it can be dumped into the batch trucks with the aggregate. It takes cement some time to harden, even after it is wet, so it could not be damaged by such a practice during the time it is in transit to the mixer. As a matter of fact, there is doubt in the speaker's mind as to whether, even after cement sent out as part of the batch, has stood for some hours, the most exacting laboratory technician could prove a measurable deterioration affecting any considerable proportion of it, if he would adopt the practical method of basing his conclusions on comparative samples of concrete mixed in the field. In any event, there is no probability that the practice of sending cement to the mixer as part of the batch with the addition of extra cement to any batches which inspection showed to have been visibly damaged by standing over night, could be responsible for

any such variation in the strength of the concrete, as now results from ordinary variations in water content that pass utterly without note or comment on many construction jobs.

An Example of "Crude" Inspection.—To just what absurd lengths the vagaries of inspection go, may be illustrated by a case reported to the writer by one of his assistants. The contractor was using four-batch trucks and was sending out the cement in sacks thrown onto the aggregate. Under the rules governing on this job he was permitted to have two trucks at the mixer with all cement emptied. One evening a breakdown at the mixer prevented the use of two such truckloads (8 batches in all), so the contractor covered them with a heavy tarpaulin and left them for use in the morning. There was no rain that night. The inspector's first act the next morning was to condemn these batches and personally to conduct the trucks to a high fill where the contents were dumped in such a way as to make any recovery impossible. The contractor offered to put an extra bag of cement in each batch. He asked to be allowed to take off the obviously good cement on the top and use that. There was no compromise. It all went over the bank! There is too much inspection of this sort in all phases of concrete pavement construction, but it is perhaps a little more arbitrary and a little more irrational where the cement is concerned than at other points with the result that contractors seem not to have dared here to work toward the modern methods that are in use in other parts of this work.

Table II—Stopwatch Studies on Concrete Road Construction

Date, 1923.	Number of Batches Mixed per Hour.	Mixer Cycle, Time in Seconds: Charge.	Mix.	Discharge.	Per Cent of Working Day Lost by Mixer from Following Causes: Insufficient Truck Supply.	Truck Delayed Because of Inadequate Number Trucks.	Mixer Trouble, Mechanical.	Mixer Delay Due to Operator.	Water Supply Trouble.	Preparing Subgrade.	Lack of Materials Due to Poor Organization.	Delay Due to Concrete Finishers.	Miscellaneous Delays.
6/11	18	9½	39½	10	...	—	...	15	...	9	...	80	...
6/12	20	9½	41	10	...	...	...	16½	...	5	...	...	...
6/12	21	9	40	12	...	9	...	16½	...	5	...	...	...
6/13	20	9½	41	10	...	9½	...	6	2	15½	...	...	...
6/15	24	9½	41½	10	...	5	...	15	6	...	...	...	...
6/19	21	9	58	12	...	3	...	17½	...	8½	...	7	...
6/20	28	10	39	10	16	1	...	6	1	...	...	...	...
6/20	30	10	39	10	6	...	...	6	2	11½	...	...	...
6/20	31	9½	39	10	14	1	...	9	...	...	...	...	9
6/25	10	10	61	10	13	21½	41½	1	...	...	...	...	...
6/26	17	9½	61	760	(1)28	1	27½	11½	4	...	...	...	...
6/26	24	9	60	12	(1)30½			4½	2	...	...	...	...
6/26	20	9½	61	10	(1)49	3		3	1	...	...	...	...
6/26	23	9	61	12	(1)30½	2	...	6	10	...	...	...	...
Averages	27.4	9.5	60.1	10.6	12.6	4.6	4.6	8.4	2.0	1.6	...	4.0	0.6
Per cent of Possible Efficiency	57.1	39.2 seconds Mixer Cycle											

Mixer was idle 39.1 per cent of working day.
Additional time lost due to slow operation of mixer, 60.9—57.1=3.8 per cent.
Note: (1) Very inadequate supply of trucks developed when hauling distance changed from 1 mile to 5 miles.

Delays in Dumping Trucks.—Turning the trucks and backing them to the mixer does not take time enough so that this operation becomes the pace-maker on the job, but cases have been observed where dumping the trucks has had the effect of controlling the rate of output. Dump truck bodies are of a good many styles. The desirable bodies are of steel and are so designed that while dumping a high angle is maintained, this resulting in a rapid flow of materials. With everything running smoothly, dumping can be done in a very short interval of time but, if the trucks must be dumped by hand, as is common with single batch trucks, a poorly placed load will sometimes result in considerable delay. However, it is only when home-made wooden dump bodies are used that the delay is at all likely to be consistently serious. On one job studied this summer there were a number of trucks equipped with wooden dump bodies which quite consistently used over a minute in dumping. As the period between the moment at which the skip is lowered, and at which it starts up again with another load, is generally less than 55 seconds, their inability to dump a load within a minute, made these trucks the pace setters to the extent of the proportion of the material which they delivered.

The other aspect of the production problem as referred to above, the synchronization of all activities, covers such matters as the amount of forms set, the rate of material delivery, the rate of finishing and curing, etc. It is not necessary to treat these at length for it is, of course, obvious that material can be mixed only as it is delivered and that, therefore, the rate of delivery must be based on the rate at which the mixer is expected to operate. In the same way, finishing must keep pace with production and the crew must be selected and trained with this in mind. Perhaps it is not quite as clear that form setting, and finishing the subgrade, are in the same category, but a little thought on this matter will serve to convince almost anyone that this is the case. There certainly is nothing to be gained by setting forms twice as fast as concrete is poured—and indeed this is not possible for the simple reason that no job has enough forms to last long at any such rate. And as for finishing the subgrade, there is too much risk involved, too much chance that rains and traffic will destroy the work to justify keeping it far in advance of the mixer.

Records of Stopwatch Studies.—The second phase of the bureau's studies in this field dealt with the matter of delays, their amount and their cause. To develop these, stopwatch studies have been made on a number of jobs. The general practice has been to take an hour's reading morning and afternoon, recording the component parts of each mixer cycle and the length and cause of each delay. Such a record is shown in Table I. These records were collected over such a period as seemed

necessary in order to obtain a fair average of operation, the hourly studies being tabulated as in Table II for more general study. The tables used in illustration are perhaps not quite as typical of conditions generally as some which could have been shown but are given here because they show the conditions prevailing on one of the jobs on which an effort was subsequently made to improve production on the basis of the data which these studies developed. The graphs in Fig. 1 show the daily and the hourly production in lin. ft. over a more extended period. What these data show, responsibility for the conditions prevailing, and the steps taken for the correction of improper conditions will be discussed under the various headings used in these tables.

The summary of the studies set down in Table II develops the following facts:

Batches mixed per hour	27.4
	Per Cent
Average efficiency of production	57.1
Average lost time	42.9
The lost time is accounted for as follows:	
Actual mixer cycle	80.2 sec.
Correct mixer cycle	75.0 sec.
	Per Cent of Working Day
Resulting loss	3.8
Mechanical trouble with mixer	4.9
Poor operation of mixer other than incorrect cycle	8.4
Shortage in truck supply	13.6
Time lost in handling trucks	4.0
Water supply	2.0
Trouble with subgrade	1.6
Trouble with finishing	4.0
Miscellaneous	0.6

Among these delays there are two outstanding groups—delays incident to the operation of the mixer and delays arising from the delivery of material—which here, as on practically all of the jobs so far studied, are the major causes of underproduction.

The delays incident to the operation of the mixer were, in this case:

	Per Cent of Working Day
Improper mixer cycle	3.8
Other improper operations of mixer	8.4
Total loss due to poor operation	11.2
Mechanical troubles	4.9
Total loss at mixer	16.1

Causes of Improper Mixing Cycles.—The extension of the mixer cycle beyond the proper limit was due to the fact that the operator failed to overlap raising the skip and discharging the drum. On this particular job, the inspector had failed to set the timer to take care of the lag in discharging the skip, with the result that the contractor had here an advantage of perhaps 3 seconds over what should have been required of him. In spite of this advantage, his mixing cycle was approximately 5 seconds long. In addition to this, he had a habit of splitting batches and often ran out the bucket and dumped it before starting the skip. He was also in the habit of moving the mixer while it was empty. The accumulation of such erroneous practices as these accounts for the 8.4 per cent of the working day charged to poor operation, other than an improper cycle. It is hardly necessary to remark here that any really first class mixer has a power plant quite capable of handling the discharge mechanism and raising the skip while at the same time driving the drum under full load. Moreover, once the discharge has been started and the skip lifted off the ground, the power plant should be capable of moving the mixer while the discharge continues and the skip is being raised. There is, then, no power plant limitation in any first class mixer which prevents operation within the cycle outlined above, except when worn out mixers are being used.

Table III—Stopwatch Studies in Concrete Road Construction (Study No. 58-B)

Date, July 31, 1925.
Number of Batches Placed, 47. Time, 1 hour.

Mixer Cycle, time in seconds.			Time (in seconds) Lost by Mixer Due to Following Causes.			
Charge.	Mix	Discharge.	Mixer Delay Due to Operator.	Insufficient Truck Supply.	Trucks Delayed Because of Mechanical Trouble.	Delays Due to Miscellaneous Causes.
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	3	..	..	..	..
10	64	3	..	..	..	..
10	64	3	..	..	..	..
10	64	1	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	63	2	..	..	..	..
10	63	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	64	3	..	..	..	..
10	64	3	..	..	..	..
10	63	2	..	..	..	..
10	64	3	..	..	..	..
10	64	2	..	..	..	..
10	64	2	..	..	..	..
10	63	3	..	..	..	..
10	64	3	..	..	..	..
Average...... 10	64	2.5	..	..	..	..
Percentage of Working Time. 13.5	83.5	3	..	..	..	..

Results of Training the Operator.—On the job under discussion no functional inadequacy existed. The improperly long mixer cycle and the other time losses incident to operation were entirely chargeable to the operator. The problem was, then, one of training the operator to handle his machine correctly. To this end, he was instructed:

First, never to split a batch.

Second, to empty the bucket only after the skip had been discharged.

Third, always to move his mixer while it was mixing.

Fourth, always to throw his skip lever and his discharge lever together and as quickly as he could after the bell on the timer sounded.

Fifth, always to close the discharge so that it would reach full cut off position just as the skip reached full vertical position.

How completely it was possible for him to attain these results will be apparent from a study of Table IV, which gives the readings taken during the last week's operation on this project, during which time improper handling of the mixer—in this case too long a cycle—accounted for a loss of only 2 per cent of the working time. This is a good record for it must be remembered that any variation from the correct cycle must be an increase. It is not possible to average at 75 seconds for that could be attained only by shortening the time on some of the batches.

Table IV—Stopwatch Studies on Concrete Road Construction

Date, 1921.	Number of Batches Mixed per Hour	Mixer Cycle, Time in Seconds.			Per Cent of Working Day Lost by Mixer from Following Causes.								
		Charge.	Mix.	Discharge.	Insufficient Truck Supply.	Truck Delayed Because of Mechanical Trouble.	Mixer Trouble, Mechanical.	Mixer Delay Due to Operator.	Water Supply Trouble.	Preparing Equipment.	Lack of Materials Due to Poor Supervision.	Delay Due to Operator Condition.	Miscellaneous Delays.
7/27	45	10	64	3	..	2½	1	..	1	..	..	..	..
7/28	44	10	64	2½	..	1	..	..	½	..	..	..	..
7/28	43	10	63½	2½	..	8½	..	..	..	..	..	..	½
7/28	44	10	64	2½	..	½	..	..	..	..	..	6½	..
7/29	43	10	63½	3	..	..	..	..	6½	..	..	..	..
7/29	46	10	64	2½	..	3½	..	..	..	..	..	..	..
7/30	38	10	64	3	..	..	..	..	2	4	11	..	..
7/30	38	10	64	3	..	3	..	..	10	..	..	..	..
7/31	42	10	64	2½	..	..	..	..	..	..	..	..	..
7/31	43	10	63½	3	..	2	..	..	1	5½	..	..	..
7/31	46	10	63½	2½	..	..	..	..	2	..	..	..	..
8/1	45	10	64	2½	..	..	..	..	6½	..	..	..	..
Average	43.7	10	64	2.7	..	2.0	..	..	2.0	0.8	1.6	..	..
Per cent of Possible Efficiency	91.0	75.7 seconds Mixer Cycle											

Time lost by mixer, 7 per cent of working day.
Additional time lost due to slow operation of mixer, 93.0—91.0, 2.0 per cent of working day.

Poorly Trained Operators.—The conditions existing on this project and the change it was possible to effect through instruction of the operator in the proper manipulation of his machine justify two or three observations. The first of these is that mixer operators commonly have been found to have only a limited appreciation of what their machines should be capable of doing and of how to make their machines function correctly. To at least a certain degree this is due to the fact that manufacturers do not fully instruct their representatives as to the capacity of their machines and how to operate them. However, a larger factor is the tendency of contractors to assume that any good laboring man can be trained to run a mixer. Practically, it has been found that this is true but it has also been found to be even more commonly true that the training is not properly attended to. During the past summer the Bureau's representatives have dealt specifically with this problem on some seven or eight mixers working under widely different conditions and in no case have they failed to obtain definite improvement in operation by the relatively simple process of explaining to the operator how his machine should be handled and showing him the result of changes made in his manner of operating. This leads directly to the second operation, namely, that the unescapable deduction from these experiences is that responsibility for lost time from this cause rests squarely on the shoulders of the job superintendent. Existing conditions are within his obvious jurisdiction and the failure to secure proper results can be charged only to him.

Lost Time Due to Mechanical Troubles.—The loss of time due to mechanical trouble with the mixer was a large item on this job. It has been found to be a large item on many jobs. Mixers wear out and like all other items of equipment must be replaced. They are, however, in a category somewhat different from the great bulk of equipment. With most of the equipment there is an opportunity to "catch up" any time lost in making minor repairs. In the event of a serious breakdown some other method of operation can often be arranged which will enable production to continue without the machine until it can be fixed. In other cases there may be a number of units employed—as, for instance, trucks—in which case a breakdown will affect only a fractional reduction in production. But with the mixer, any loss of time is instantly reflected in the production. Indeed, to stop the mixer is to stop production. This is wholly unavoidable. Therefore, the mixer should receive outstandingly good care and ought to be replaced more often than most other items of equipment. The payroll on a concrete paving job commonly runs in the neighborhood of $200 a day. Depreciation on equipment is at a rate generating a cost of perhaps half that amount, often more. These two accounts, to mention none of the accounts of lesser importance, can be said, in a general way, to amount to $300 a day or to 50 cents a minute. If, then, the mixer is losing 5 per cent of the time, this is 30 minutes, worth $15 a day, or somewhere between $1,500 and $2,000 during a good working season.

Mechanical difficulty may be due to the use of a worn-out mixer, to occasional breakdowns which, in turn, are likely to be the result of poor operation, or to careless or indifferent maintenance. If, from the latter causes, responsibility for them, as in the case of the poor performance of the operator, rests squarely on the superintendent. In the case in hand, the almost total absence of mixer trouble during the period covered by Table IV is to be ascribed, at least in part, to the more

complete training of the mixer operator and to the greater emphasis laid on proper care of the mixer. It was a comparatively new machine and should have given little trouble. If mixer trouble is due to the fact that the machine is worn out it can be corrected only by a complete overhauling or by the purchase of a new machine. To work with a machine that is losing upward of 5 per cent of the working time is too expensive to be considered for a moment by a wide-awake contractor.

Another observation which may appropriately be made at this point is that the correction of conditions at the mixer, at once affects losses at other points, notably in the transportation supply.

Importance of Effective Instruction of Men and Effective Planning of Work.—In the case at hand, losses which had been amounting to over 16 per cent of the working day were, by careful instruction of the operator (see Table IV) reduced to 2 per cent of the working day. As an inadequate truck supply already was responsible for a loss of 13.6 per cent of the working day, the corrections made at the mixer could have had no value whatever without a change here. They would, in short, merely have operated to increase truck shortage to 27.7 per cent. The objective in a construction operation is production. Obviously, the greater the production per man and per machine, the more favorable the position of the contractor. Any effort at efficiency which falls short of this result is a hopeless failure. But, in the studies of efficiency which have so far been made, there is one thing that has been conspicuous,—that it is not, on the whole, more effort per laborer employed which is needed. Rather it is more effective instruction of the men and more effective planning of their work. Laboring men at once sense any lack, either in knowledge of the work or in ability properly to direct it, but they respond at once to the efforts of any leadership which enables them to work more effectively. So, while it has often been observed that mixer operators, as a single example, are difficult to handle if an effort is made to correct conditions at the mixer, when ordinary practices there generate a rate of production which exceeds the possible rate of material delivery, it has been the uniform experience that, if crowded by the development of an improved rate of material delivery, they will work diligently to master an improved system of mixer operation. It is, therefore, not only useless so far as the effect on output is concerned to improve the operation of the mixer if the material supply, where already inadequate, cannot be improved, but it is also likely to be impossible to correct the rate at which other operations are performed, for the men involved are likely to so keenly appreciate the utter futility of it all that they will not respond.

On the job under discussion, the material delivery losses were:

	Per Cent of Working Day
Inadequate truck supply	13.6
Improper handling of trucks	4.0
Difficulties with water supply	2.0
Total	19.6

Truck Operation.—In making these studies readings were, of course, made at the mixer. Improper handling of trucks there, slow dumping and difficulty in handling caused by bad subgrade were causing a loss of 4 per cent of the working day. Slow dumping was later largely corrected by placing the stone in the

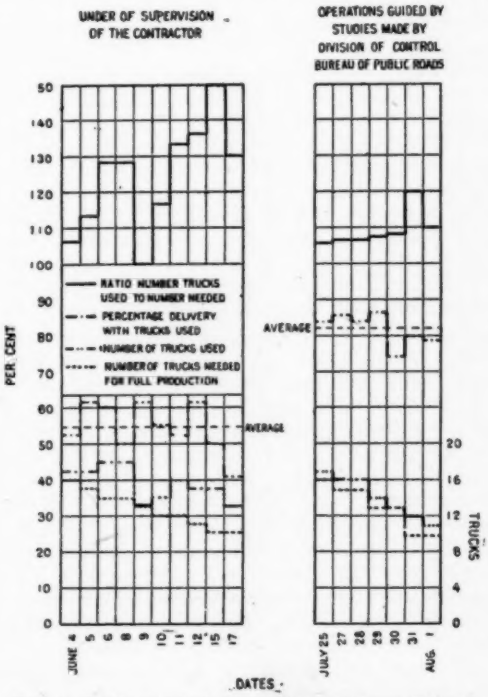


Fig. 2—Study of Truck Operations on Same Federal Aid Project

back of the trucks which were of the single batch, hand dumped variety. This largely eliminated time losses due to slow dumping. The bad subgrade conditions were never fully eliminated. This tended to correct the deficiency in truck supply but could not, of course, eliminate it.

The fact of a truck shortage as shown by readings at the mixer indicates merely a shortage under existing operating practices. Single batch trucks travel at an average rate of about 15 miles an hour. The bureau's studies show that about 4 minutes are required per load

hauled, for servicing operations such as loading sand and gravel, loading cement, traversing loading plant, operation of turntable, etc. These facts generate the formula

$$T=8d+4$$

in which T is the trip time in minutes and d is the distance from the material loading plant to the mixer in miles. With this formula, it was possible to subject the existing truck supply to analysis to ascertain how many loads per day should have been delivered. By comparing the number of batches which should have been delivered with the number actually delivered, it was possible to determine the efficiency with which the trucks were being operated. Fig. 2 gives graphs showing the efficiency of truck operation under the contractor's management and as developed under the guidance of the Bureau's representative. For the period under discussion the average truck operating efficiency was about 64 per cent. In short, instead of an actual deficiency in the truck supply, the average truck supply available during this period was such that, had it been properly operated, a surplus would have resulted. This statement, of course, deals with averages and is satisfactory for a general analysis of the transportation situation, but for immediate job control, it is not sufficient, for averages, to be really significant, must deal with a situation in which there is opportunity to exceed a desired condition as well as to fall below it. In work of this kind, this cannot be done, for today's surplus truck supply cannot be used to increase today's run or to improve tomorrow's, if there will then be a deficiency. To correctly appraise the situation for proper job control, each day's work must, therefore, be considered by itself. Viewed from this angle, there would, at times during this period, have been some truck shortage, if all operation had been on a high plane of efficiency and no additional trucks had been made available. This will, perhaps, be a little clarified by the graphs in Fig. 2 which give some of the details as to the truck supply and its management.

The detailed analysis of efficiency with which the trucks were being operated included stopwatch analyses of service rendered the trucks, i.e., loading, turning, backing and dumping, etc., for the purpose of learning and correcting the various causes of delay. The stopwatch studies also developed the trucks which habitually ran either fast or slow and thus interfered with a uniform delivery on schedule time. The details of this work need not be discussed at length here but a few observations may be of interest. Thus, on work of this kind, it has been uniformly found that where a uniform travel speed is not maintained efficiency is reduced. If trucks are run at a speed greater than that established for the job, they are worn out more rapidly with increased depreciation and repair cost as well as a higher percentage of time lost in the repair shop. Accidents enroute, collisions, etc., are of more frequent occurrence. In short, general confusion in operation results, with nothing much on the other side of the ledger, for, though the truck which has been speeded up may obtain a few extra loads during a day's run, these are commonly obtained at the expense of some other truck so that no increase in amount hauled, taking the fleet as a whole, results. This arises from the fact that each servicing operation takes time and that, therefore, while the speeding truck may come in ahead of its place in the line, this merely results in its reaching the material yard with some other truck or trucks which must then wait for service, losing on the whole about as much time in going through the material yard as the speeding truck has gained.

The slow truck, of course, shows a direct loss of time itself, and also causes those delayed by its slow driving not only to lose time on the road but also to lose time waiting for service in the material yard. The net result, then, of both slow driving and fast driving is to injure the contractor, and whenever either is found to exist, if the drivers fail to co-operate in correcting the condition, they should be summarily discharged.

Good Supervision Essential for Best Performance.—On the other hand, it may be remarked that while high production requires a rigidly scheduled delivery of material it is unfair to the men to assume that unassisted they can accomplish this result. Indeed it is as hard to maintain the material delivery schedule without adequate supervision as it would be to maintain a complicated train schedule without a dispatcher. Good supervision is essential. The men should be given proper information as to the trip time which is to be required. Speedometers would be a great assistance to them in maintaining the proper speed. They should be rigidly held to proper performance but they should be given adequate means of determining that they are rendering proper performance. Here again superintendence now is wholly inadequate. It is not enough that men should be told what is desired. The conditions surrounding their work should be such and their detailed instruction should be such that the result desired can be secured.

Another matter relative to the truck supply is that, in practice, even with the best of supervision, perfect performance is all but impossible of attainment. The elimination of delays in servicing and the introduction of a

standard driving speed will improve material delivery. On another project, studied by another of the Bureau's men, the truck supply was inadequate throughout the period during which an effort was made to improve production. Under the contractor's management the efficiency of truck operation had commonly ranged between 70 per cent and 75 per cent. By correcting the difficulties arising in connection with servicing, by keeping the trucks on schedule, etc., the efficiency of operation was raised to about 98 per cent, but it could not be raised to a full 100 per cent for any extended period and held there. A punctured tire, a train at the railroad crossing, a momentary holdup due to other traffic on the road, not to mention more of the numerous occasionally encountered causes of minor delay, would cause the trucks to fall a little below full efficiency. From this and other experiences with this problem, the conclusion has been reached that it is sound practice to use a truck supply somewhat in excess of that theoretically required. On the job under discussion, one extra truck was used, except that on one day two extra trucks were used, but the results obtained do not indicate that any increased rate of production resulted.

Where in excess truck supply is used the computed efficiency of operation will, of course, be correspondingly reduced. This explains the fact that an operating efficiency generally ranging between 80 per cent and 85 per cent was maintained during the high production period shown in Tables III and IV and in Fig. 3. In the last analysis the question as to what excess truck supply it is well to maintain must be determined by the conditions prevailing on the job in hand. It has been shown that in a general way time lost at the mixer costs the contractor 50 cts. a minute. The loss, for instance, of 5 per cent of the working day costs him perhaps $15. The loss of 10 per cent of the working day costs him perhaps $30 a day. The time of one single batch truck will cost perhaps $10 a day. There is here, then, what may reasonably be termed a choice of evils for expense is involved no matter which choice is made. In a general way, the higher the efficiency of operation, the less a contractor will need to provide by way of extra truck supply. But, as an efficiency of operation exceeding 90 per cent is astonishingly difficult of attainment, it is thought that, as a general proposition, a 10 per cent excess truck supply is the lowest that it will ordinarily be wise to use.

Inadequate Transportation Facilities.—Another aspect of this case is that inadequate transportation facilities are the rule rather than the exception on paving jobs. Indeed, much of the poor progress made on this work is directly traceable to this cause. Contractors should give more thought to this matter. In the very nature of the case, the force employed on other than hauling work must be maintained at practically constant size without regard to the yardage laid per day. The amount of equipment on the job is, of course, constant. Daily payroll and depreciation charges, therefore, remain about the same, whether production is high or low. On the other hand, varying the number of trucks does not vary the cost per batch hauled. It merely affects the rate of delivery. It, therefore, naturally results that any under supply of transportation sharply increases the cost. On the other hand it is rather a common practice to use all of the transportation all of the time. This is wholly indefensible. To keep the cost of hauling at a proper level the number of

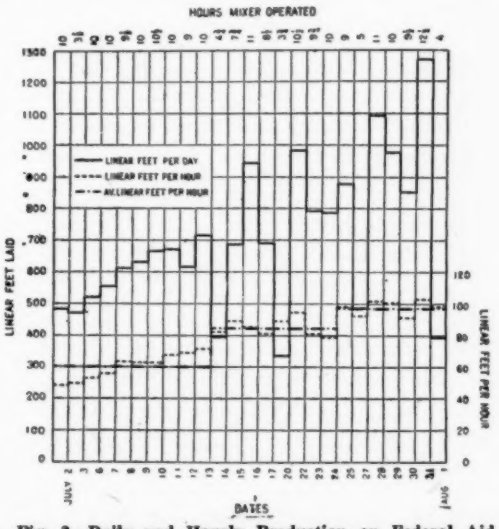


Fig. 3—Daily and Hourly Production on Federal Aid Project in Fig. 1, When Operations Were Guided by Studies Made by U. S. Bureau of Public Roads.

trucks worked should be in close harmony with the number required. A reasonable excess in the truck supply as insurance against the loss of time at the mixer is proper but to keep more than this merely serves to increase the cost of hauling. A brief study of the formula for the time required per trip will show that, except for the influence of the constant, which is of minor importance except on short hauls, the time per trip and therefore the cost of hauling varies directly with the distance hauled. In other words, hauling materials to the third mile will cost about three times as much as hauling them to the first mile if the transportation used is kept in harmony with the work to be done. On the other hand, to work all the transportation all of the time results in

making each mile equally expensive until the full distance at which the trucks can supply the mixer is reached! Operation of this sort ruins profits.

The Water Supply Important Consideration.—The water supply is not commonly so considered but actually is part of the material supply. It is, of course, apparent that anything that interferes with the water supply stops production. The water supply is, therefore, an important consideration. Without going into the matter at length it may be observed that time losses in this field arise from a number of causes. Generally speaking, the most conspicuous of these is moving the hose to another pipe line outlet. As commonly conducted, this operation stops production for from 5 minutes to as much as 10 or 15 minutes. This loss takes place two or three times a day. It can be wholly eliminated by using a double hose connection on the mixer and having two lengths of hose on the job. It can be largely eliminated by careful and systematic work in moving the hose. The latter was used on this job.

Inadequate water supply often is a cause of trouble. The common practice today on paving jobs is to use 2-in. pipe for carrying the water delivery. This is a leave-over from the days of the 3-bag paver, but for serving a modern 5-bag paver pipe of this size is totally inadequate. A 3-in. pipe is the smallest that can appropriately be used for while the mixer can generally be served through a 2-in. pipe, to do so generates pressures at the pump and in the line which are ruinous. Moreover, one of the outstanding features of most concrete paving work today is the utter inadequacy of the supply of water available for curing. One seldom sees a pavement which, in dry weather, is properly wet down. The cause is apparent enough. The contractor, with his existing 2-in. pipe, simply cannot run his mixer and meet the specifications governing curing.

On this job, preparing subgrade caused a loss of 1.6 per cent of the working day and finishing the concrete caused a loss of 4 per cent of the working day. Other miscellaneous items caused a loss of 0.6 per cent of the day. These last commonly are small difficulties that cannot be foreseen.

Inspection and Specifications.—Losses of time due to subgrade as well as losses of time due to finishing should never occur. The mechanical means available for handling the subgrade and for handling the finish are so simple and so effective that these operations ought never to affect production. On this particular job, the underlying difficulty really was erratic inspection, which suggests that there are a few matters in regard to instood both by contractors and engineers. One of these is that the specifications should be view as a whole. Years ago an outstandingly brilliant professor at the University remarked to the writer:

"It is impossible to learn architecture by taking the bricks out of a wall and studying them with a microscope! Rather, one sits on a hill and meditatively considers the beauty of the structure as a whole."

This is equally true of specifications. Much of the trouble which contractors have in dealing with inspectors arises from the fact that the latter, or the engineer directing him, in looking at the specifications with a microscopic range of vision has brought into this moment's field of vision some one item which he then proceeds to enforce without the slightest apparent conception of its real relation to the general structure which any complete specification actually is! As a result the enforcement of specifications becomes unbalanced. On a job recently studied the inspector told one of the writer's assistants, that as long as the center point was straight none of his bosses paid any attention to the rest of the work! This appeared to be literally true for the finish was rough, many of the batches were wet, no particular attention was paid to how the reinforcing was placed, and the accuracy of subgrade finish left much to be desired, to mention only a few of the conditions prevailing. But let the center joint get a little out of line and there was trouble enough!

Another matter that gives contractors a great deal of trouble is the clause "or to the satisfaction of the engineer" and its many equivalents. Any discussion of efficiency, to be at all complete, must make reference to the fact that the tendency of engineers and inspectors to view such clauses as "carte blanche" to make any requirements they please costs contractors a great deal of money. The modern tendency in writing specifications is to define methods, materials, practices and tolerances with considerable clarity. This practice is open to the criticism that it deprives contractors of the incentive to use their ingenuity in improving these and thereby favorably affecting cost. But while it is not unlikely that the time may come when more latitude will be given contractors and with it more opportunity for constructive thinking in the field of methods and practices, the fact remains that a correct interpretation of existing specifications would not only relieve contractors of much worry and expense but would help toward this end for the clause, "or to the satisfaction of the engineer" both legally and historically, refers only to the engineer's authority in regard to other specified methods, materials, practices, usages, tolerances, etc. The engineer

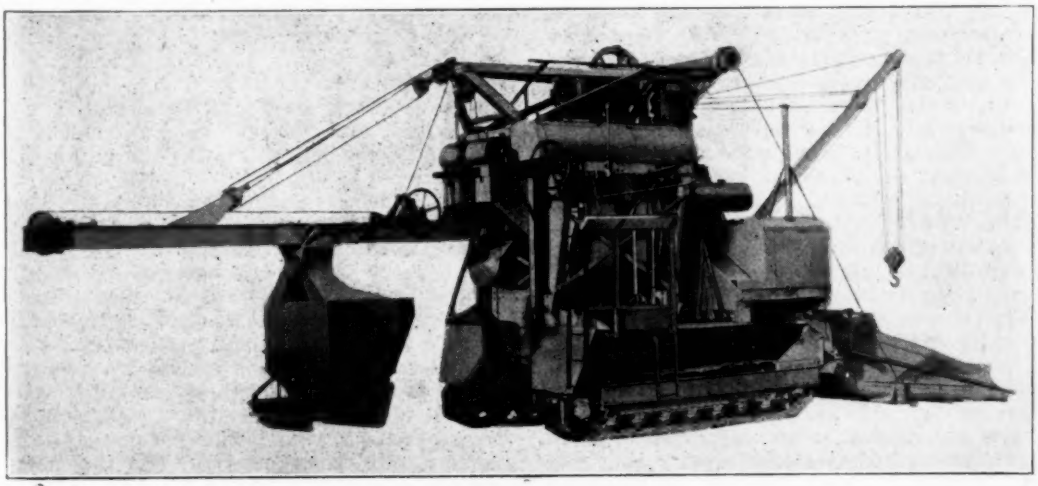
himself commonly has no authority to initiate changes, but rather is required both historically and legally, to accept and permit the use of practices, etc., which in his judgment are equal to these prescribed whenever the contractor desires to make such substitution. The common attitude among engineers that a new method, different materials, unusual proportions, etc., though under test offering finished work as good or better than that specified, should be refused, especially if the contractor's profit may thereby be improved, obstructs constructive thinking, needlessly increases cost to the contractor, hurts the engineering profession, and, in all of these ways, acts needlessly to increase the cost paid by the public for a valuable paving material.

The losses in time having been determined and the remedies devised as discussed above, there remains nothing but the actual application of these to the job in question. To change the practices in force on a going job takes time. A month was required on this project to develop a rate of efficiency deemed fairly satisfactory. At first progress was slow but as the men became familiar with the new ideas, they worked diligently toward the desired end with the result that, during the last week of the test period, production was consistently maintained at a reasonably satisfactory level. The results are shown in Fig. 3.

In closing it may be pertinent to remark that there was nothing unusual about this project. These and other studies indicate that efficiency in production is not a matter governed by local or regional conditions. Given good supervision, a trained appreciation of what the elements of supervision are, and proper equipment with which to work, production equal to or better than that secured on this job during the last week of the Bureau's direct contact with it, should be secured on any other job having a good 5-bag mixer, with the necessary correlated equipment, and this without regard to where it is working.

Synchronized Action on Rex Paver

Charging and discharging actions are stated to have been synchronized to such a point in the 1926 model of the Rex 27-E paver of the Chain Belt Co., Milwaukee, Wis., that the drum is mixing concrete practically all of the time. To accomplish this a timing scheme has been worked out in which the actual filling of the drum begins the moment the drum has discharged its previous batch. In practice, synchronized timing works out in this way: The paver operator throws in his skip clutch immediately after he opens his discharge. Just as the last of the mixed batch goes out the discharge, the first of the unmixed batch slides from the skip into the drum. The engineers who designed this effective synchronization system on the Rex 27-E followed the two test machines into the field last summer and stayed with them for some time. One of these machines laid approximately 95,000 sq. yds. of pavements. In this way they checked closely the action of the machines under actual condition, and observed just what the effects of synchronized timing are. The 27-E Rex Paver is a 6-bag machine on a 1-2-4 mix, and will handle this size batch on a 6 per cent grade.



The New Rex 27-E Paver

Correlation of Transportation Agencies

Inter-Relationship of Highways, Railways and Waterways Discussed in Paper Presented Feb. 22 at Short Course in Highway Engineering at University of Illinois

By C. C. WILLIAMS

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Transportation is the life blood of a nation or of a community just as communication is the nervous system. Let a city be marooned by a snowstorm or a strike for a week and this fact becomes distressingly apparent. Groceries, meat and milk supplies and all life necessities become exhausted in an amazingly short period. We live daily in this "hand-to-mouth" fashion without ever thinking how immediately transportation affects our vital existence. The more adequate the transportation facilities the more completely may supplies be stored efficiently in large store houses rather than in inefficient local rooms. The vital importance of transportation renders imperative adequate facilities properly correlated in function and in operation in the first place and, in the second place, an assurance that these facilities will be designed with a sufficient factor of safety to prevent their complete failure due to the breakdown of any one of the component parts.

The Primary Agencies of Transportation.—What are the primary agencies of transportation which should thus be correlated? Waterways, railways and highways are patently the only agencies which may be expected to carry any considerable portion of the bulk of transportation and because of the similarity and possible lapping in function, these agencies should be correlated according to inherent characteristics and capacities so as to serve their purpose most effectively and most economically.

It is difficult to set down the essential characteristics of these agencies in any complete manner, yet a few outstanding features which affect their inter-relationships should be mentioned.

Waterway Transportation. — Waterway transportation under favorable conditions is slow moving and cheap per ton-mile, and restricted to a definite line rather than covering an area. It requires a considerable haul by other agency with the concomitant transfer of commodities in order than an area of territory be served. It is thus the most circumscribed and inflexible of the three agencies of transportation. It is primarily suited to hauling coal, ore, steel, stone, and similar commodities which do not suffer deterioration and whose delivery is not urgent and which can not pay a high rate.

The Railways.—Railroads are incomparably more effective in serving the entire area of the country than are the waterways, although even with the railways, a local haul is necessary. However, this local haul is much shorter than in the case of the waterways. The cost per ton mile is slightly greater than on waterways, and the difference would be even more pronounced, except for the adjustment of railroad rates to shield bulk commodities from sustaining their full share of fixed charges. The velocity of transit is rapid although serious delays occur in local handling of commodities. The connections with local transportation agencies at terminals is cumbersome, time consuming and productive of deterioration to commodities, and probably constitute the chief weakness of the railroads as a transportation agency.

The Highway.—Highways constitute the most elastic as well as the most expensive transportation agency, since they reach the door of every family and business. The cost of transportation by waterways, railways and highways for actual haulage per unit are of the scale 0.7, 1.0, 2.5. Indeed, if fixed charges were all accounted against highway transport, the cost would be considerably increased even over the figure mentioned.

As to reliability and safety, railroads are supreme by a large margin. For the most part, no insurance or other financial responsibility is operative to shield the patron of highway transport from bearing the loss in case of accident, although the larger companies do afford such protection. With regard to passenger traffic, on the basis of passengers killed and injured per million passenger miles, highway transport is about 15 times as hazardous as railway travel.

The Magnitude of the Various Transportation Agencies.—The mileage figures, 4,500 for feasible waterways, 250,000 for railways, 2,941,000 for highways, in the United States, give a rather vague conception of the relative magnitudes. A projection of these on the map of the United States would better serve the purpose. Imagine a waterway east and west from New York to San Francisco

and one north and south from Chicago to New Orleans, and you have essentially the magnitude of our waterways fully developed. Again, imagine a steel mesh with 22 mile squares laid over the U. S. and you have a picture of the railroads. Fill in this mesh with a finer mesh of two mile squares and you have a picture of the highway mileage.

Approximately $21,000,000,000 represents the investment in railroads and about the same for highway transportation, including about $14,000,000,000 in motor vehicles and about $7,000,000,000 in highways. The total operating expenses of the railroads amount to approximately $6,000,000,000 per year and the automotive operating expenses approximately twice that figure.

In the above data of waterways, only those projects which seem to be feasible are included, namely the Great Lakes-St. Lawrence system, the Mississippi river system, and the coastal canals, including Panama Canal. While some difference of opinion exists as to the extent that waterways will enter as a factor in the transportation strategy of the country, it is reasonable to assume that the next decade or two will see a considerable amount of shipping on the inland waterways. To argue that waterway operation under no circumstances can be made economical because the railroads in their aggressive days of expansion swept shipping off the inland rivers is not sound logic.

To suppose, however, that the antiquated stern or side wheel steamer will be restored to its former splendor is, of course, fatuous. It would be almost as reasonable to expect the ancient two-wheeled ox cart to return to compete with the auto truck. The modern efficient barge represents progress in shipping as do the truck and the mikado locomotive. While the Great Lakes-St. Lawrence system, a reasonable development of the Mississippi system and certain coastal canals to facilitate coastwise shipping are doubtless feasible projects, to count on cross country canals, and the navigation of branches of the Mississippi generally would as surely be a stupendous error. The inelasticity of waterways due to their being restricted to fixed lines without branches extending to the origin of traffic circumscribes their usefulness in this age of high velocity transportation.

The railways, in contrast, form an irregular network over the country connecting all centers of population of any appreciable size. Except in the mountain and arid regions, no one lives far from a railroad. These lines at present overlap in function, compete with each other wastefully and are largely without coordination in their operation, except as economic pressure has strangled the weaklings and prospered those favorably situated. In such a random transportation machine, cost of service is a rough guess and a scientific rate structure as well as superior service through differentiation of function are impossible. However, it is reasonable to expect the proposed consolidation of railroads to proceed under the aegis of the Transportation Act until a separation of function with highly developed trunk lines, secondary lines and feeders, may be made possible. Until such unification and coordination of railroads is accomplished, discussions of correlation between highways and railways

Natural Relationship of Transportation Agencies.—With the above general characteristics and data in mind, what will be the natural relationship insofar as they may be discerned between the agencies of transportation? Should legislative enactment supplement natural economic laws in preventing wasteful competition and overlapping of territory and of function? How may these agencies be best accommodated to yield the most effective and the most economical service?

In Illinois, it is doubtful if any future waterway development will have a potent influence on the highway program in general. Chicago as a port for foreign shipping will later alter railway strategy, but probably not radically affect highway locations or required capacities. With the Illinois River and upper Mississippi as a water carrier if they should develop considerable proportions in that respect, connections to existing highway routes may be easily made. Such connections would be particularly valuable, of course, as a factor of safety by making waterway-highway transportation available in the event that through strikes or other cause the railroads should be thrown out of commission. Inland waterways will never again be considerable carriers of passengers, hence, their cooperation with highways, which are primarily passenger carriers, is limited. Moreover, waterways are best adapted to hauling coal, etc., commodities which could not be hauled advantageously over highways. For these reasons, the necessity of a direct and permanent connection between waterways and highways as transportation agencies is remote.

These statements concerning waterways and highways apply generally to the nation as well as to the State of Illinois. The principal commodities adapted to waterway transport are low-rate slow moving freight, a class entirely out of range of highway haulage. For these reasons, there can be neither competition nor cooperation to any appreciable extent, under normal conditions, between highways and waterways. Railways occupy a transportation zone lying between highways and waterways, which laps and therefore competes under pres-

ent conditions with both, and may cooperate with both. To find the limits of these zones of most efficient and economic operations, is obviously our quest.

Highway Passenger Traffic.—Transportation of persons which affords comfort, pleasure and convenience will naturally justify a high rate, hence, passenger travel on highways may be expected to be heavy. However, for long distances where a time schedule must be met, the more reliable, safer and cheaper railway will continue to be the chief agency used. One day driving marks a practical limit of distance for highway passenger travel, except for touring where economy of time is not involved. However, these limitations do not prevent highways from making serious inroads on the passenger traffic of steam and electric railways where improved routes parallel the latter. In support of this statement, the fact that, while passenger traffic per capita normally increases about as the square of the population, the passenger traffic per capita actually decreased about 8 percent in 1924 as compared with 1910. This decrease actual and potential, was doubtless due chiefly to automobile competition. Statistics from various parts of the country clearly show a marked loss in passenger traffic due to the highways. Long distance and commutation railroad travel have made normal gains, hence, the traffic taken by the highways is short distance, irregular travel. This situation has caused many local passenger trains to be discontinued, and others would be discontinued if regulatory commissions would permit.

Truck Haulage.—Auto trucks have made no marked impression in the tonnage carried by railroads, although the effect on net revenues has been appreciable, owing to the fact that high rate commodities have been taken from the railroads by the highway. Indeed it is probable that the highways have augmented railroad freight traffic as feeders rather than diminished it through competition. L. c. l. or package freight rather than di7890$.... r-fi or package freight for short hauls is being carried by trucks to a considerable extent chiefly because of the superior quality of service rendered by the highways.

A shipper dislikes to contract with a local drayman to haul his goods to the freight house, the contract with the railroad for carriage and supervise the checking and listing, and then after much delay and business of rechecking at destination, contract with yet a third party to complete the haul from the receiving freight house to the door of his house. To contract with one carrier who will make the complete door-to-door haul, and make it in a day instead of a week, with much less bother of crating, etc., is a convenience for which anyone is willing to pay a very fair premium.

In general, highways are taking business from the railroads not by offering a cheaper service, but by offering a superior service at a higher cost.

Correlation of Highways and Railways.—With regard to the correlation of highways and railways, the subject falls under two heads: (1) transportation outside the terminal area of potentially competitive transportation and (2) transportation within the terminal area of supplementary transportation.

As stated above, definite limitations are set by the characteristics of track operation to highway transportation generally. Surveys in Connecticut and elsewhere show that more than two thirds of truck haulage is for distances less than 30 miles and that very little is hauled more than 70 miles. Competition between railroads and highways will be generally for hauls less than 50 miles and will be for high-rate package freight. Commodities subject to rapid deterioration such as fruit, milk, etc., and those needed for emergency will properly be hauled over the highways even at considerably higher rates, because of the more expeditious service. Also highly specialized commodities which for railroad shipment require heavy and expensive packing, such as furniture, glassware, etc., can be hauled advantageously and economically on the highways for the maximum distance.

The coordination between highways and railways competitively in freight business then involves under present operating conditions, a surrender on the part of the railways the haulage of short haul high-rate commodities under present operating. This situation makes a disproportionate inroad on freight revenues because this class of commodities is largely "the cream" of the business, and doubtless the railroads will devise means through improved service of recovering a portion at least of this business.

Coordination of Railways and Highways within Terminal Area.—The coordination of railways and highways within the terminal area, the second part of the problem, offers in my judgment an alluring promise of development. The solution of the problem may be summed up in a phrase, namely, storedoor collection and delivery of freight by the railroads. Such service was in vogue in England before the days of motor trucks and has increased in importance since their advent. By instituting collection and delivery, either by a truck service under their own direction or under a subsidiary company, railroads might readily cause improved highways to be advantageous as feeders as are connecting railway lines. The railways through taxes contribute heavily to the construction of streets and rural highways, and have as good right to use them as has any other citizen, and they might do so

to very great advantage to themselves as well as to the public.

A modification of equipment by use of containers or other device which will facilitate the transfer of commodities between track and car will be necessary for satisfactory coordination, for a theoretical economic relationship between railways and highways is meaningless unless there is a physical device for making this relationship in a practical way.

With organized collection and delivery service railroads might, at large terminals advantageously substitute direct cartage for railroad haul for part of the short hauls and the interterminal service. The cartage costs so overwhelmingly predominate in any shipment in and out of large terminals, that such shipments should carry a rate primarily based on cartage plus a small addition for railroad haul. Obviously the entire transportation under such circumstances could be advantageously conducted by one company. Such organized cartage would act potently toward relieving the congestion of streets which results from the present haphazard individual cartage methods.

Such cooperation as is involved in collection and delivery has so many alluring possibilities, that an extended discussion of this subject alone would be justified but times does not permit, since other aspects of the general topic must be mentioned at least briefly.

Street Railways and Motor Busses.—One other aspect of the correlation of transportation agencies must be mentioned, namely the relation of street railways and motor busses in cities. Electric street railways in many if not most cities in America are in financial difficulties. Securities have shriveled to one third or one half of par value and dividends are only a pleasant memory. A number of causes have contributed to this situation, such as bad financing, restrictions on fares with mounting operating cost, etc., but probably the most puissant factor is motor-bus competition.

The situation is a serious one, particularly in large cities, for the street railway is indispensable. Yet revenues at ordinary rates render its financial existence precarious. American cities largely because of the prevalence of a uniform 5 cent fare for so many years and the fact that they are planned as overgrown villages clustering about a town square have highly concentrated and congested business districts requiring transportation of large numbers to and from such business districts daily, with the attendant unbalanced traffic.

If the street railways should cease to operate, motor-vehicles on the streets would be utterly inadequate to care for the traffic, chiefly because of lack of street capacity. Passengers in electric railway cars occupy a small fraction of street space that they occupy if transported in private automobiles, and considerably less than if transported in auto-busses. Auto-vehicles would fall far short of the capacity required at peak load conditions in most cities of 100,000 population or more. Moreover, in inclement weather motor vehicle transportation is less reliable than street car service.

It is true that local transportation in London and some other European cities is largely provided by busses, but owing to the absence of concentrated business or industrial districts, no congestion of transportation arises to such as exists in most American Cities, consequently their transportation facilities would not suffice for our conditions.

Private automobile transportation is not only inefficient and expensive to the city, but is much more expensive to the car owner than is street car transportation. This is particularly true where the owner must provide parking space at his own expense.

The accommodation of street railway service and motor vehicle transportation in cities is perhaps the most acute angle of the relationship between these two agencies of transportation, and unfortunately, a general solution is least obvious. In fact, it is probably safe to say that no general solution exists but that the situation in each city will need to be adjusted on its merits according to local conditions. In the cases which have come to my attention for special study, the removal of street cars from sparsely settled areas with the substitution of bus service seems to be a first step in the adjustment. For those who use private cars in pleasant weather and street cars in bad weather a system of fares that will throw to them a just proportion of the ready-to-serve cost of street car service seems to be a next step. A realization of the community dependence upon adequate transportation and provision for social or community sharing of responsibility for the success of the transportation authorized by the community government is perhaps the third requirement. The instrumentalities for effecting this adjustment do not constitute a part of the present theme. Suffice it to say that the suggested adjustment does not transcend practical procedure.

For small cities, bus transportation with higher fares seems to be the agency best adapted because of the minimizing of fixed charges.

Urban transportation is too large a theme to be discussed exhaustively in so brief a survey, and since each city presents a case for special study, only general lines of procedure are suggested above.

Regulation of Bus and Truck Companies.—Any discussion of a correlation of transportation agencies would be incomplete without a reference to regulation. Most of the states attempt regulation of bus and truck companies by requiring a certificate of "convenience and

necessity" from state authority, for the operation of transportation lines over the highways. In many states, whether there exists adequate transportation by steam or electric railways is an essential consideration on determining the propriety of issuing such a certificate of convenience and necessity. In at least three states no restriction is placed on competition with railways on the part of highway transport agencies. Such lack of regulation can result only in serious economic loss eventually with corresponding inconvenience to the public.

Generally, state regulation of highway transport is placed very appropriately in the hands of the state public service commission. It is probable that in the case of highway operation affecting interstate commerce the time will come when a more complete regulation of interstate routes by Federal authority will be found desirable, just as the concentration of railway regulation has gradually shifted from state to Federal authority.

Even rural highways have ceased to have a primary relation to agriculture, for improved highways are located to connect cities and are primarily avenues of commerce rather than mere aids in marketing of crops. Whatever Federal control of highway operation should be under the same bureau that regulates railroads. The Department of Commerce through the Interstate Commerce Commission is a more logical instrumentality for regulating highway operation from the Federal viewpoint than is the Department of Agriculture. Likewise state regulation of bus and truck companies doing intra-state business should be under the control of the same body that regulates intra-state steam railroads and electric and street railways. Both state and Federal regulatory bodies will need to act vigorously if a period of serious economic waste through improper competition is to be avoided.

Summary.—Let me summarize briefly in conclusion.

1. Of the three agencies of transportation, railways occupy the middle zone, and overlap both waterways and highways to a certain extent, requiring adjustment with both. Waterways and highways at opposite ends of the transportation scale have no direct connection of prime importance.

2. Railways constitute the chief agency of freight transportation, except for package high-rate freight for short hauls. Railways will be forced to surrender much of this business and to readjust their methods in order to minimize the amount surrendered.

3. Highway transport will inevitably compete with the railways for passenger traffic, particularly for distances within a day's ride. Long distance and commutation passenger business will be carried by railroads, the former because of economy and the latter because of street congestion.

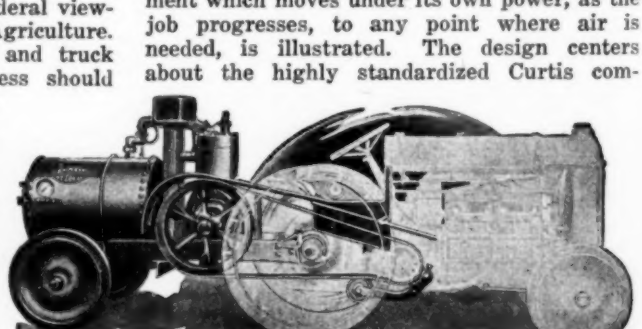
4. For urban transportation electric railways are indispensable in large cities; in medium cities, street railways are necessary but will have to be fostered by the community if they are to prosper; in small cities, the street railway in most cases may be forced to retire from the field before the elastic, low-fixed-charge bus service.

5. The proper correlation of these agencies of transportation requires a concentration of control. State and Federal control should be in one the same bodies which are charged with the regulation of railways, both steam and electric.

Adequate transportation is essential to community life, either local or national, and to secure the most effective utilization of the agencies available, it is necessary to understand their natural spheres of operation and to adopt a certain amount of artificial regulation in order to prevent wasteful competition and to promote most efficient cooperation and coordination.

Portable Compression for Fordson

A compressor outfit of 100 cu. ft. displacement which moves under its own power, as the job progresses, to any point where air is needed, is illustrated. The design centers about the highly standardized Curtis compressor itself with its necessary equipment on an all structural steel frame with two wheel mounting. All is complete in itself and ready for use, needing only to be coupled by means of six bolts to any standard Fordson tractor. The unit is stated to have a capacity capable of operating a rock drill for a depth of 12 ft., or two drills down to 6 ft. depths, two paving breakers, or three back fill tampers, or three riveting hammers, or many other types of air tools. The compressor is made by the Curtis Pneumatic Machinery Co., 1925 Kienlen Ave., St. Louis, Mo.



Curtis-Fordson Combined Compressor Unit

Highway Maintenance Problems

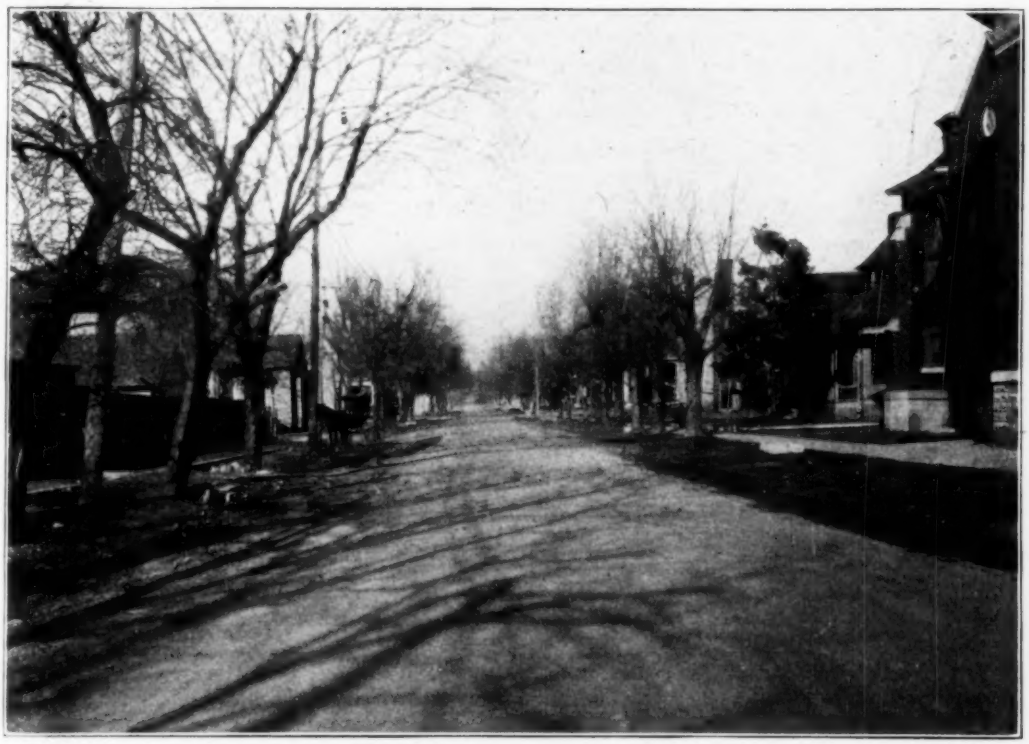
A Well Directed and Sustained Program Important

By F. H. GILPIN
Engineer, The Texas Co.

The constant increase in mileage of improved highways and streets is emphasizing the importance of a well directed and sustained maintenance program. Many of the larger municipal or state units with years of experience with all types of paving recognize the necessity of starting maintenance as soon as construction is completed. No right of way should be considered so unimportant as to be neglected. Too many times money is spent for maintenance only on the streets or roads where a great investment has been made. Again, excessive amounts have been expended in favored locations to the neglect of other places possibly of lesser importance but in which there is considerable investment subject to depreciation. It is true that maintenance funds are limited and frequently insufficient. However, a policy of progressive maintenance that preserves investment and shows results increasing with the years frequently wins over the taxpayer to the idea, and greater funds are forthcoming in subsequent years.

Maintenance System Should Be More Than Intermittent.—A forward-looking program covering several years should be devised, keeping individual section costs if possible. Too often where maintenance barely keeps a highway in existence, a little foresight would have put off for years the necessity of resurfacing or reconstruction. The function of maintenance is to replace wear or erosion, excluding water from the base and subgrade. Successful maintenance should cover the entire right of way, or at least from drainage line to drainage line. Where the paved surface alone is maintained erosion of the shoulders either by weathering or traffic will many times result in greater damage to the pavement than direct wear.

In every type of construction some provision should be made for replacement of loss by wear and for the repair of local failures which are bound to occur. As the initial cost of the pavement increases, so should the interval before extensive general maintenance begins. Adjacent structures may require con-



Street at Murfreesboro, Tenn., Treated One Time

stant attention lest their failure advance the day of reckoning. Certain types of hard surface pavements—frequently miscalled "permanent"—have features of minor deterioration which, though initially of no apparent moment, require constant attention to prevent serious failure through neglect. Probably more investments in pavements are lost through neglect and lack of attention than are destroyed by excessive traffic. If left alone and untraveled, the elements unaided will eventually destroy any type of construction. The less resistant to water absorption a pavement is, the more rapid is the effect.

The Problem of Stone, Gravel, Sand-Clay or Kindred Surfaces.—The very nature of these surfaces makes them satisfactory under modern high speed traffic only when they are continually protected by maintenance methods. Maintenance by surface treatment should be prescribed, as a hard surface pavement is designed to balance the traffic requirements. Do not wait until the surface has so worn as to greatly reduce the road's efficiency. Forestall the wear by maintenance of the good surface. Whether the treatment should be occasional or progressive depends on the character of the surface and traffic. When the surface treatment is an adjunct or necessary step in the completion or preservation of wearing surfaces such as waterbound macadam, gravel, sand-clay, penetration macadam or old hot mix or other hard surface types, the amount of care to be taken in the preparation of the surface in many cases measures the success or failure of the work. Soft spots, disintegrated areas, depressions, high spots and shoulder breaks should be repaired or adjusted so as to present an even contoured surface of uniform hardness for treatment. Weak or loose areas show up sooner or later in the mat formed. Dusty areas should be well swept off

Repairing a Worn Pavement With Cold Patch.

and where the wearing course is well bound mechanically, the main aggregate should be exposed so as to present a sound foundation to which the surface mat may adhere. Where the treatment is mainly for dust laying, and no mat or wearing surface is to be formed, less preparation is usually necessary as the purpose of the treatment is to consolidate the loose particles on or just below the surface.

Covering an Application of Asphalt Surfacing Material on One of the Roads of Long Island, N. Y.

Bituminous Material and Mineral Aggregate Cover.—The character of mat desired controls the selection of the bituminous material and mineral aggregate for cover. They should be determined upon both from their suitability to the purpose, and their relation to each other. More frequently than otherwise, available sources of local cover materials are drawn upon without proper regard to their suitability. With different classes of bituminous materials selected gradings of the aggregate will give the most satisfactory results. In general the heavier the bituminous binder used and the thicker the mat to be formed the coarser should the aggregate be. Too small an aggregate not only reduces the efficiency of the bitumen but creates a tendency to bunch and roll.

Modern mechanical equipment for applying the bituminous material insures uniform distribution at practically any desired temperature without damaging the material. As the slope of the road surface from center to shoulder increases, it becomes increasingly difficult to apply and retain uniformly a heavy coat at temperatures above what might be considered normal. Where a heavy application is desired and where the temperature necessary for a smooth, uniform application causes appreciable run-off to the shoulders, it is better by far to make two light applications. Distribution of cover material, except in large organizations, is usually by hand. It is obviously impossible thus to obtain as uniform a distribution of mineral as of the bituminous material. Certain areas are bound to have an excess of cover and others a deficiency, thereby creating initial inequalities in character of surface which will develop into waves or ridges. Lack of uniformity in grading of cover will cause similar results. If immediately after application of cover means were provided to even out the distribution much future annoyance could be avoided. The tendency in the covering to "blot up" all fat spots caused by run-off increases the depth of mat irregularity along the edges—creating the objectionable humps so frequently met.

After the completion of the "surface treatment," attention should be given the road at frequent intervals until the mat has entirely set up and the bitumen has taken up all the mineral aggregate it will hold. All areas that seem imperfect should be replaced as in construction work and shoulders brought up or cut down to smooth out the contour of the road. Maintenance should be considered as a preventive instead of a remedy.

Unit Prices on Iowa Road Work

The following list, from the Service Bulletin of the Iowa State Highway Commission, shows the average unit prices in 1925 on various types of work and material used in road building in that state:

Paving	$2.4528 per sq. yd.
Gravel	$.3929 per cu. yd. screening, loading, haul 1 mi. and spreading.
	$.0762 per unit of additional half mile haul.
Grading	$.21855 per cu. yd.
Bridging	$22.72 per cu. yd. concrete in place.
Structural Steel	$5.50 to $7.47 erected I-Beam spans.
	$3.75 to $3.94 f.o.b. county.
	$5.25 to $10.00 trusses erected.
	$4.45 to $5.767 f.o.b. county.
Reinforcing Steel	$2.788 ⅝" round new billet.
Lumber	$35.04 3'x12' stand. sawed Doug. Fir.
	$39.20 3'x12' full sawed Doug. Fir.
	$39.25 3'x12' stand. sawed White Oak.
Piling	$.261 16' Red Cedar.
	$.187 16' Cypress.
Cement	$2.44 Dealers Net Prices f.o.b. Cedar Rapids.
Corrugated Culverts	$1.419 24" lin. ft. LCL f.o.b. county.
Drain Tile	$.1142 per lin. ft. complete.

Motor Vehicles in Indiana.—The total revenue collected from the license fees for the 735,097 motor vehicles registered in Indiana in 1925 was $4,649,662.

Compression Tests of Concrete Cylinders

Preparation of Ends of Cylinders Described in Technical News Bulletin of U. S. Bureau of Standards

The comprehensive strength of concrete mixtures is generally determined by breaking 6 by 12 in. test cylinders at the age of 7 and 28 days. In order to obtain a true compression failure, it is necessary to have the ends of the cylinders true planes perpendicular to the axis of the cylinder. Considerable time and attention are required to secure this condition. Heretofore the Bureau of Standards has used a steel cylinder mold for casting the cylinder. The inside circumference of the mold is machined, and the mold rests on a flat steel machined plate which gives a true plane at the bottom. About four hours after the cylinder was cast the top was brushed and a cap of neat cement paste about $\frac{1}{32}$ to $\frac{1}{16}$ in. thick placed on it. After remaining in the mold 24 hours the cap was scraped to a true plane with a steel straightedge, the top of the mold being used for a guide during the scraping operation.

With the object of lessening the time and labor in preparing the ends of the cylinders the bureau purchased a surfacing machine to reduce the upper surface to a true plane. The machine proper consists of a standard to which is attached a vertical electrically driven grinding wheel. The abrasive wheel is cup shaped, approximately 18 in. in diameter, with a cutting surface about 4 in. wide around the circumference and about 4 in. thick. The cylinders are held by a strap iron in a V-block mounted on a horizontal steel platform. The platform is carried on a rocker motion which allows the cylinder to pass back and forth across the grinding surface of the wheel, and a screw feed permits any given amount of the cylinder to be fed to the grinding surface. The V-block can be turned through 180°, so that both ends can be trued without removing the cylinder.

Recently some tests were run to obtain a comparison between the compressive strength of a concrete obtained from cylinders capped in two ways with the use of the machine and that from cylinders capped according to the usual methods. A 1 : 2 : 4 by volume gravel concrete having a flow of 100 was used to prepare the cylinders. In all cases the standard methods of molding the cylinders were carried out with the exception of preparing the ends. The specimens were cured in a damp atmosphere, and five of each kind were broken at the ages of 7 and 28 days.

The methods of capping were as follows: (a) Molds filled level full with the concrete and the top of test specimen ground to a true plane just before breaking. (b) The usual bureau laboratory method outlined above. (c) Specimens capped as in (b), but instead of the scraping operation the ends ground just before breaking. (d) A neat cement cap placed on the specimens approximately 24 hours before breaking. The results obtained are given in the following table:

Age.	Character of Determination.	Variation with different methods of capping			
		A Per cent	B Per cent	C Per cent	D Per cent
7 days	Average deviation from mean	3.6	2.6	4.0	5.0
	Maximum deviation from mean	5.6	4.3	10.0	7.2
	Strength based on B as 100 per cent	112	100	102	120
28 days	Average deviation from mean	4.5	4.2	3.1	6.6
	Maximum deviation from mean	9.4	7.6	6.8	12.8
	Strength based on B as 100 per cent	102	100	102	107

The results of the preliminary tests show that the same strengths are obtained for the same concrete with the use of the machine as with the usual method of capping, and the variation from the mean average strength is within the range of usual laboratory results. The merit of the machine is that a true flat surface can be ground at either or both ends of the cylinders at a great saving of time as compared with the former scraping method.

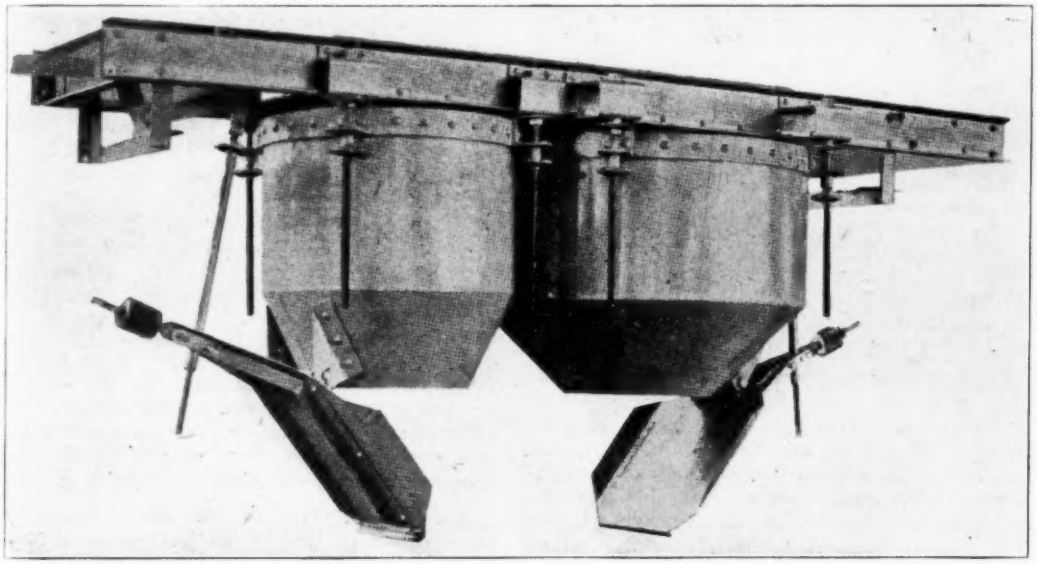
Meetings of District Engineers in Michigan

An excellent plan for securing coordination of activities of district highway officials has been carried out during the past winter in Michigan. The plan, established by Frank F. Rogers, State Highway Commissioner, called for regularly scheduled meetings of the district engineers and other employees of the department in each district. These meetings were attended by the maintenance supervisor and clerk of each county. The sessions were designed as clearing houses for general information and understandings of the various problems which confront the Maintenance Supervisors and engineers in each district, and to smooth out details of operation. The program at each session dealt with subjects of interest relative to proper classification of maintenance costs and all of the details entering into trunk line road maintenance, and instructions for preparing monthly reports, payrolls, equipment rental, material reports and other details entering into the engineering activities in each district.

New Measuring Batcher

A single control batcher which is stated to perform the complete operation of filling, cutting off, dumping the batch of sand and stone, closing the lower and opening the upper gates in less than 10 seconds, is a recent development of The Heltzel Steel Form & Iron Co., Warren, O. The batcher is operated by a single lever. The upper and lower gates automatically interlock, producing, it is stated, accurate and uniform batches. Provisions are made for quick and accurate adjustment to compensate for bulking due to moisture content.

The sand batcher has a standard capacity adjustable from 8 to 14 cu. ft., and the stone batcher has a standard capacity adjustable from 13 to 28 cu. ft. Both have loading indicators to show when full or empty. The batcher frame is a heavy steel channel. All operating parts are attached to the frame. The upper gates have 14-in. diameter openings. The slide cut-off rolls on line-point wheels. The lower gates have 18 in. diameter openings. Drop chute type interlocking with upper gates and operated by single control lever. The batcher shell is round in cross-section. The height over all when adjusted to 13 cu. ft. capacity is 3 ft., when adjusted to 28 cu. ft. capacity, 4 ft. 8 in. The batcher frame is drilled for attachment to practically any type of bin now on the market, whether steel or wood. The batcher is shipped completely assembled, ready for operation. The shipping weight is approximatly 1,400 lbs.



The Heltzel Batcher.

Now One Motor Car for Every 5.8 Persons in U. S.

More than twenty million motor vehicles were in use on the highways of the United States in 1925, according to the Bureau of Public Roads of the U. S. Department of Agriculture. The total registration reported was 19,954,347, but there were in addition 96,929 State and Federal government-owned vehicles not included in this figure. The increase in registrations during the year amounted to 2,360,670 or 13.4 per cent. Florida reports an increase of 46.8 per cent, while Utah, Mississippi, Alabama, Arkansas, North Dakota and Texas all report increases of more than 20 per cent. Truck registration increased 14.5 per cent for the entire country. New York leads in total registrations with 1,625,583 followed by California, Ohio, Pennsylvania and Illinois in the order named, all with registrations of over a million. There is now one motor vehicle for each 5.8 persons in the United States. California has only 2.9 persons for each motor vehicle, while Iowa has 3.6, Nevada 3.7, Kansas 4.0 and Oregon 4.0. At the other end of the list is Alabama with 12.0 persons per vehicle, but ranking among the highest in increase during the year. The total revenue from registration fees, permits, etc., amounted to $260,619,621, of which $177,706,587 was made available for state highways, $19,124,014 for state road bonds and $48,396,471 for local roads.

Slag Aggregate and Designed Mix

Special Construction Methods in Alabama Concrete Road Job Described in Concrete Highway Magazine

By ALLAN L. WALLACE
Resident Engineer, Alabama State Highway Com

In October, 1924, the Alabama Highway Commission awarded to the Houston Construction Co. of Houston, Tex., the contract for grading, draining and paving the 23 miles of State Highway No. 45 in Calhoun County. This is one of the longest stretches of highway ever paved under one contract in the state.

Construction started at the southern end of the project. The materials were proportioned at a central plant and hauled to the two 21-foot Smith mixers by a fleet of 40 Ford trucks. The state specifications prohibit hauling loose cement so the six sacks necessary for each batch were laid upon the aggregate in the truck and the cement was dumped when the truck arrived at the mixer. The proportioning plant was set up at three locations which were so evenly spaced that the average haul on the 23 miles of work was only 3 miles.

Washed sand from Montgomery was used as fine aggregate and basic blast furnace slag from Birmingham as coarse aggregate.

Construction Methods.—Construction methods for slag concrete are a little different from those in common use with other coarse aggregates. Birmingham slag weighs about 80 lbs. per cubic foot and has a French coefficient of from 5 to 6. It is porous, the pores varying from those left by minute air bubbles to considerably larger holes, like the cells of a small-scale honey comb. Because of this porosity it absorbs moisture like a blotter and will take much of the moisture from the mixed concrete. To prevent this the coarse aggregate bin was supplied with perforated water pipes which sprayed the slag and kept the pores filled with moisture.

In placing and finishing, slag concrete requires special treatment. There are always a few very light pieces which float to the surface. These cannot be submerged by the finishing apparatus and must be picked from the surface by hand and discarded.

The edges of pieces of slag are usually sharp, so that they will catch upon belts and cause the slag to roll. This is prevented by removing the belt from the finishing machine and following the mechanical striking and tamping with a longitudinal float, operated by two men from bridges which span the pavement. Next, excess water is pushed to the sides of the slab and pieces of sharp slag on the surface are submerged by a long handled metal roller, which is operated by one man who stands along the side forms. When the concrete has stiffened a little, a bow belt gives the surface its final finish.

Designing the Mix.—The Southern Testing Laboratory inspected all materials and also designed the mix. They furnished a field laboratory and an inspector, who was continually on duty at the proportioning plant. At least once a day the plant inspector made a sieve analysis to determine the fineness modulus of both fine and coarse aggregate. The sample for this test was taken in small amounts from about 25 trucks just after they had been loaded. The average fineness modulus of the sand was about 2.80 and of slag about 7.31. There was very little variation in individual samples, the sand ranging from 2.70 to 2.90 and the slag from 7.20 to 7.35. Using 1.6 bbls. of cement per cubic yard of concrete, and the highest fineness modulus which will give a workable concrete, a minimum 28-day strength of 3000 lbs. per square inch was secured while the average strength was 4300 lbs. per square inch.

Materials were measured by volume and it was also part of the inspector's duty to determine and allow for the bulking of the aggregate. The sand contained from 3½ to 5 per cent of moisture and the average bulking was 1.30. Moisture has little effect upon the volume of slag and its bulking was not determined.

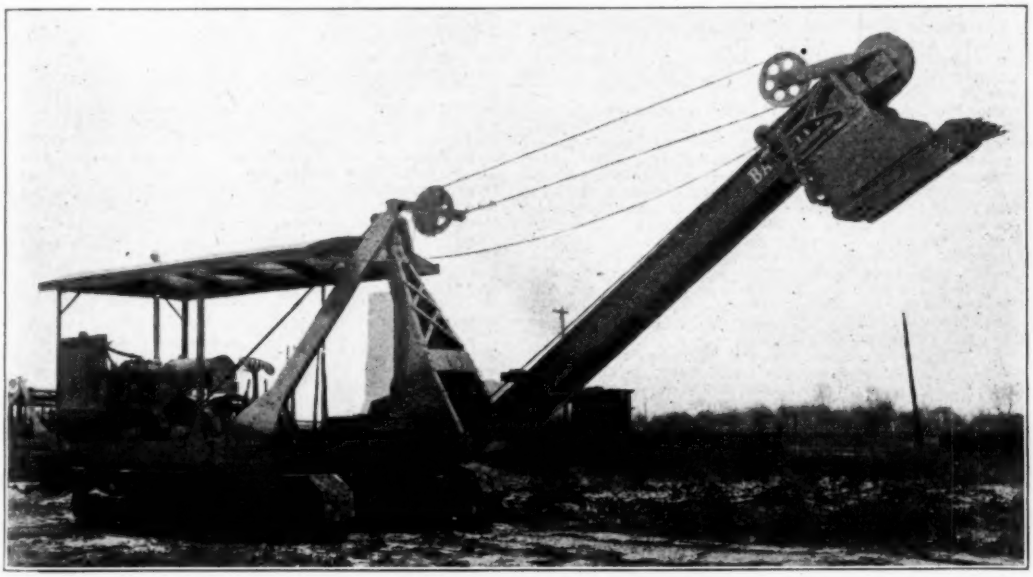
The road inspector made slump tests at frequent intervals and once a day cast a 6 by 12-in. concrete cylinder which was sent to the laboratory for test in compression. About 5½ gal. of mixing water were used to get a workable concrete with a slump of from ½ to 1 in.

The cross section of the slab is a slight modification of that which has commonly become known as the "Illinois type." The edges are 9 in. thick, decreasing in 3 ft. to a uniform thickness of 6 in. In preparing the subgrade for this thickened edge slab the tandem roller was found more effective than the 3-wheeled type. Expansion joints were put in at 40-ft. intervals.

U. S. Population Nearly 116,000,000.—The population of Continental United States totaled 115,940,000 on Jan. 1, 1926, according to estimates of the National Bureau of Economic Research. This is an increase of 1,629,000 over the estimate for Jan. 1, 1925, and shows a population gain of more than 10,000,000 since the United States Census was taken at the beginning of 1920.

Full Crawler Bay City Excavator

The Bay City Dredge Works, Bay City, Mich., is now making its 16-B excavator with full crawlers. All the former 16-B features and advantages have been retained, and the feature of increased mobility and easy steering added. On the new machine the size of the clutches and bands have been increased slightly and the skimmer-ditcher trip rope is located so the operator can reach and operate it, thus doing away with the ground man. The crawlers on the new machine have a width of tread of 16 in., and overall length of tread of 14 ft. 6 in.



Bay City 16-B Excavator with Full Crawlers

and a height of tread of 30 in. The dimensions of the frame are: Overall length of the car body, 16 ft. 2 in.; overall top clearance (height), 11 ft. 6 in.; overall width, outside crawlers, 9 ft. 1 in.

New Trade Publications

The following trade publications of interest to highway officials, engineers and contractors have been issued recently. Copies of them can be obtained by addressing the firms mentioned:

Hydrated Lime and Concrete.—"Better Concrete Roads" is the latest bulletin issued by the National Lime Association, 918 G St., N. W., Washington, D. C. It is an attractive book 6 in. x 9 in. in size, 20 pages, in two colors throughout. The numerous illustrations are construction views. The bulletin deals with the use of hydrated lime for controlling consistency and obtaining uniformly dry concrete. The material has been compiled from data obtained from a number of highway jobs.

Traction and Operating Equipment.—The International Harvester Co., 606 South Michigan Ave., Chicago, Ill., has issued a 94-page catalog devoted to its tractor and the special units and attachments used with it. These units includes air compressors, road crushers, loaders, cranes, road machinery, trailers, etc. In fact, the catalog is a very comprehensive compilation of the many types of tractor operated equipment now on the market.

Road Graders.—A new 56-page catalog has just been issued by J. D. Adams & Co., Indianapolis, Ind., The various machines are illustrated and described and their specifications are given. In addition to many illustrations showing Adams graders on all sorts of grading work, the catalog contains many practical suggestions on road building and maintenance.

Use of Cal in Concrete.—"Quick Hardening Concrete" is the title of a bulletin issued recently by the North American Cement Corporation, Hagerstown, Md. It deals with the use of Cal in concrete. The subjects considered include: "Fundamental requirements for good concrete work," "Acceleration," "Effect of accelerators on strength or concrete," "Effect of curing on the strength of concrete," "Effect of water ratio on strength of concrete," "Reducing the water through the use of Cal," "Aids in frost proofing and indensifying," "Use of Cal to correct unsoundness in concrete."

Road Building Machinery.—A 64-page catalog of the highway construction and maintenance equipment has been issued by The Good Roads Machinery Co., Inc., Kennett Square, Pa. The equipment is illustrated and described and specifications are given. Numerous illustrations of the machine on the job are shown.

Castings for Street and Sewer Work.—The Campbell Foundry Co., Harrison, N. J., has issued a catalog showing detailed drawings of a number of its standard designs of castings for paving and sewer work.

Concrete Mixers.—A catalog illustrating and describing its 75 Dandie concrete mixer has just been issued by the Koehring Co., Milwaukee, Wis.

Self Loading Scrapers.—A bulletin "Road Officials and Baker Maneys" has been issued by the Baker Manufacturing Co., Springfield, Ill. It points out how Baker Maney self-loading scrapers can be used effectively and economically along with blade grader equipment in solving many grading problems. In addition the bulletin shows how Baker Maney trains can be used independently on special projects which would otherwise entail large outlay for labor and teams.

Industrial Notes

The Harnischfeger Corporation, Milwaukee, Wis., manufacturers of gasoline excavators and trenching machines announces the appointment of Wm. H. Hale & Co., as agents in the state of Minnesota, with headquarters at 607 5th Ave., South Minneapolis, Minn.

The Portland Cement Association announces the appointment of R. M. Simrall as District Engineer of its Kansas City office, located in the Gloyd Bldg. The Kansas City office has charge of Association work in western Missouri and Kansas. Mr. Simrall was formerly one of

the field engineers in Kansas and prior to joining this organization was engaged in various engineering work in Oklahoma and Missouri.—The Portland Cement Association also announces the opening of an office at 939 "O" St., Lincoln, Neb., under the direction of Donald D. Price, District Engineer. This office has charge of Association work in Nebraska. Mr. Price has been connected with the Portland Cement Association for the past year and a half as field engineer in Nebraska. Since his graduation from the Civil Engineering Department of the University of Nebraska, he has filled a number of important engineering positions in the state, as well as having engaged in consulting engineering practice.

Lawrence E. Buzard has been appointed general sales manager of The Fate-Root-Heath. Co., manufacturers of Plymouth gasoline locomotives, Plymouth, O., succeeding H. R. Sykes who recently resigned. Mr. Buzard, who was formerly assistant sales manager, has been with the company a number of years and is thoroughly conversant with industrial haulage problems. He will have direct charge of locomotive sales and 34 district sales representatives.

The Heltzel Steel Form & Iron Co., Warren, O., has appointed Chadwick Bros. Co., Cor. 25th & Clybourn Sts., Milwaukee, Wis., as its representative on steel sidewalk forms, curb forms, curb and gutter forms, etc., in the state of Wisconsin.

The Portland Cement Association announces the appointment of Forest Kaufman as manager of the southwestern offices of the Association. Mr. Kaufman's headquarters will be in the Gloyd Bldg., Kansas City. The Southwestern Offices comprise the following District Offices: Kansas City, Oklahoma City, Dallas, Lincoln (Neb.) and Denver. These offices have charge of association work in the states of Kansas, Nebraska, Oklahoma, Texas, Wyoming, Colardo, New Mexico and western Missouri. Mr. Kaufman has been with the Association since June, 1916, serving first as field engineer in Illinois. A year and a half later he was appointed District Engineer in charge of the Kansas City office and later made District Manager in charge of Kansas City and Oklahoma City offices.

J. L. Latture Equiment Co., 354 Belmont St., Portland, Ore., has been appointed sales representatives of the Climax Engineering Co., Clinton, Iowa, manufacturers of Climax "Trustworthy" engines and power units. The J. L. Latture Equipment Co. has as sales territory in the states of Oregon, Washington, and Idaho.

The Construction Machinery Co., Waterloo, Ia., has recently placed its line of Wonder tilting mixers with the Cunningham-Ortmayer Co., 14 Grand Ave., Milwaukee, Wis., and the R. E. Brooks Co., 50 Church St., New York City.

Harlan A. Pratt has been appointed manager of the Oil and Gas Engine Department of the Ingersoll-Rand Co. Mr. Pratt was connected for many years with the Sales Department of the Westinghouse Electric & Manufacturing Co., later becoming sales manager of the Atlantic Elevator Co., exclusive agents in the East for Westinghouse gearless traction elevators. For the past three years he has been Sales Manager of the Elevator Supplies Co., of Hoboken, N. J. Mr. Pratt is a graduate of Stevens Institute of Technology, and a former Director of the American Institute of Electrical Engineers.

At the recent annual meeting of stockholders of Albaugh-Dover Manufacturing Co., manufacturer of "Zones of Quiet" gears and A-D speed reducing units, Chicago, Francis G. Eppley, for many years superintendent of the plant, was elected a director.

The T. L. Smith Co., Milwaukee, Wis., manufacturers of concrete mixers, announce the following appointments of distributors: The Coast Machinery Corporation of San Francisco, Calif., has been appointed exclusive distributors of the entire Smith line in the Frisco territory. The LaLance Equipment Co., of Huntington, W. Va., has been appointed exclusive distributors of the entire Smith line for southern West Virginia. The J. Z. Horter Co., of Havana, Cuba, has been appointed exclusive distributors of the entire Smith line for all of Cuba. All three companies will carry a complete stock of mixers and repair parts so that prompt service will be offered at all times.

Officials of Monarch Tractors, Inc., announce the completion of their plans for removing the business from Watertown, Wis., to Springfield, Ill. Under these plans a new Illinois corporation has been organized with a capital stock of $600,000 to take over all of the tractor business of Monarch Tractors, Inc., except the Watertown lands and buildings. The new company has purchased an excellent factory site in Springfield which will enable the production of Monarch 5 and 10-ton tractors to be very largely increased. The new plant at Springfield is of modern brick and steel construction with some 80,000 sq. ft. of manufacturing space all on one floor, and with several acres of ground adjoining to permit of future expansion. Alterations and additions are now being made to the plant and it is expected that machinery and equipment from Watertown will be moved and the new plant will be occupied by the middle of April. The name of the new Illinois firm is Monarch Tractors Corporation and the officers are as follows: R. W. Gotshall, president; H. B. Baker, vice-president; R. C. Lanphier, vice-president; Owsley Brown, secretary and treasurer. Messrs. Gotshall and Baker joined the Monarch Company several months ago as respectively in charge of production and sales and in the new company they will have the joint and entire active management of the business. Mr. Gotshall for 15 years was connected with the Holt Mfg. Co., at Peoria, Ill., in engineering, production and other executive capacities, and for the past six years was assistant general manager of the Peoria plant. Mr. Baker had been general sales manager of The Holt Mfg. Co., at Peoria, for the past 12 years. Associated with Messrs. Gotshall and Baker in the Monarch organization are other men who were formerly associated with them in similar capacities in the Holt Co., and who have had long and valuable experience in the development of the track-laying tractor industry both in the factory and in the field. These include E. F. Norelius, chief engineer; J. A. Geiser, general factory superintendent; W. J. Gottschalk, assistant treasurer, and W. V. Kauffman, purchasing agent.

M. Maximillian, aged 55, special railroad representative of the Chicago Pneumatic Tool Co., 6 East 44th St., New York City, died suddenly, March 9th, from heart failure at his hotel, Richmond, Va. He had been connected with the Chicago Pneumatic Tool Co. for many years as a member of its sales organization, first as district manager, Seattle Branch, and later special representative in the railroad department. He enjoyed a wide acquaintance throughout the country, and particularly among the railway mechanical men. His remains were taken charge of by the Masonic Order of which he was a member.

The Bates Machine & Tractor Co., Joliet, Ill., has completed its reorganization. A new company, the Bates Manufacturing Co., has been incorporated and has acquired the plant at Henderson Ave. and Jackson St., Joliet, and all other assets of the old company. The capitalization of the new company is given as $401,000. It will conduct its business under the same management as the predecessor company had. The company will build the crawler type farm tractor known as the Bates Steel mule, a line of heavy crawler type tractors for road building, and crawler machinery for converting Fordson and other tractors into the crawler type for road building. Corliss engines, general power plant machinery and feed water heaters also will be manufactured.

Meetings and Conventions

American Sand Association.—Meeting at Cleveland, Ohio., April 13.

Building Construction Employers' Association.—Meeting at Chicago, April 13.

National Industrial Conference Board.—Meeting at New York City, April 15.

National Warm Air Heating and Ventilating Association.—Meeting at St. Louis, Mo., April 14-15.

Montana Section, American Water Works Association. Meeting at Butte Montana, April 15-17. H. B. Foot, Director, Division of Water & Sewage, Department of Public Health, Helena, Mont.

American Welding Society.—Annual convention, 29 West 39th St., New York City, April 21-23. M. M. Kelly, Secy., 29 West 39th St., New York City.

National District Heating Association.—Convention, Niagara Falls Hotel, Niagara Falls, June 1-4. D. L. Gaskell, Secy., Greenville, Ohio.

American Water Works Association.—Annual convention, Hotel Statler, Buffalo, N. Y., week of June 7, 1926. Beekman C. Little, Secy., 43 City Hall, Rochester, N. Y.

American Society for Testing Materials.—Convention Haddon Hall, Atlantic City, N. J., June 21-25. C. L. Warwick, Secy., 1315 Spruce St., Philadelphia, Pa.

American Society of Mechanical Engineers.—Spring convention, San Francisco, Calif., June 28-30. Calvin W. Rice, Secy., 29 West 39th St., New York City.